RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

WITH WHICH IS INCORPORATED

ROADMASTER AND FOREMAN

BRIDGES--BUILDINGS--CONTRACTING--SIGNALING--TRACK

Published by THE RAILWAY LIST COMPANY

WILLIAM E. MAGRAW, President and Treasurer
CHAS. S. MYERS, Vice-Pres. — L. F. WILSON, Vice. Pres. & Editorial Director
C. C. ZIMMERMAN, Bus. Mgr. — KENNETH L. VAN AUKEN, C. E., Editor
J. M. CROWE, Mgr. Central Dist. — OWEN W. MIDDLETON, B. S. M. E., Editor
DALTON RISLEY, Western Manager

Contributing Editors: A. M. WOLF, C. E. (Concrete); J. G. VAN ZANDT, C. E. (Economics); B. W. MEISEL (Signaling)

Office of Publication: Manhattan Building, Chicago
Telephone, Harrison 4948
Eastern Office: 50 Church Street, New York
Telephone, Cortlandt 5765
Central Office: House Bldg., Pittsburgh
Address all Editorial and Business Communications to the Company at Chicago

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, signaling, bridges and buildings.
Communications on any topic suitable to our columns are solicited.
Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 15 cents. Advertising rates given on application to the office, by mail or in person.
In remitting, make all checks payable to the Railway List Company.
Papers should reach subscribers by the twentieth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.
This Publication has the largest paid circulation of any railway Journal in the Maintenance of Way field. Of this issue 5,800 copies are printed.

Entered as Second-Class matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

New Series Vol. 10
Old Series Vol. 29
Chicago, March, 1914
No. 3

CONTENTS.

†Broadening Field for Railway Engineers 87
†Through Arch Bridges of Reinforced Concrete 88
†Trestle Abutments 88
†Location and Construction of High Class Coal Road 88
†Steel Design, Bay City Bridge 89
†Thornton Goes to England 89
†A Prospective Engineering Feat 89
*St. Louis, Peoria & North Western Ry. 90
Wallman Mfg. Co. Establishes Chicago Branch 99
New Books 99, 112
*Novel Type of Reinforced Concrete Abutment 100
Twenty Years Ago This Month 111
*Hunt Nut Lock 112
The American Railway Engineering Association 113
*The Interpretation of Experimental Data 116
Concrete Department—
†The Location of Construction Joints in Concrete 119
Current Prices—Concrete Materials 119
*Through Arch Bridges of Reinforced Concrete 120
The Signal Department—
*The Characteristics of a Gravity Cell 129
The Maintenance of Way Department—
†Causes and Prevention of Rail Creeping 131
*Handling and Removing Snow 133
Burning to Cure Gumbo Slides 134
Larger Section Gangs, Without Extra Gangs 134
Economical Maintenance 135
Rail Ravelings 135
Correspondence—
Creep or Travel of Rail 136
Patents and Inventors 136
Drainage 136
Attitude Toward Track Men 136
Slides on Mountain Track 137
*Toronto Freight House 137
*The Engineer's Distress 138
*Personals 140
With the Manufacturers—
Some Interesting Exhibits 146
Beall Tools 148
*An Old Time Transit 149
Western Correspondence School 149
*Combination Rail Brace and Tie Plate 149
*Side Clearing Tell-Tale 150
*Tie Tongs 150
The Jones Purchasing Agency 150
A. E. Schafer 150

†Editorial.
*Illustrated.

Broadening Field for Railway Engineers

A VERY marked tendency can be noted in recent appointments of engineering officials into the operating department. This tendency has gradually increased on the roads with departmental organizations until it now presents a very important aspect.

On the roads with divisional organization this policy is not new, appointments being made frequently from the engineers, although men from other departments are eligible.

Some years ago certain railways with departmental organizations inaugurated a policy of appointing roadmasters from among their engineers, and this was in a sense a transfer to the operating department. This movement was a failure in the majority of cases. The reasons for this were three-fold: (1) the appointees were not always the engineers with a practical turn of mind, and the most capable engineers would not consider the position as its opportunities did not measure up to those in their own department; (2) more important than the former reason, however, is the fact that most of these engineers had had no practical track experience, or no very great experience as engineers in special charge of track work; (3) the stand taken by many of the engineers a number of years ago was one of smug superiority which prevented them from familiarizing themselves with the work by learning from the practical track men in their employ.

Since that time the attitude of engineers as a whole has radically changed. A college education is now considered only a training which fits a man to learn his calling. And this training which teaches him to investigate and get to the bottom of things is beginning to be looked upon as an asset which enables a man to rapidly acquire the fundamental details of a position, and also gives him an initiative which results in studies which redound to the benefit of the individual and to the railway. The tendency most strongly noted is the promotions of engineers maintenance of way to superintendents, and in this connection it is well to note that, in the great majority of cases, these positions are filled by men who have risen by sheer ability, many times passing men older in the service, although the preference is usually given to the older men, other things being equal.

The position of an engineer maintenance of way on most departmental railways is an ideal training for the position of superintendent. His position is mainly in a consulting capacity, with the difference however, that he usually devotes much time to inspections of work being done and work completed by other departments, according to plans made in his office and staked out by his engineers. A man in such a position has a most excellent opportunity to watch the operation of a division as a whole. His responsibilities in the construction part are small, and this leaves him free to observe and benefit fully by the work, while defective methods many times are unnoted by those directly in charge, on account of lack of time.

There is in addition to the above a still stronger reason for the tendency mentioned, and that is the present mode of advancing a man who starts work as a member of a train crew. The unions insist that seniority must govern entirely in the promotions of all these men, up to and including the position of train conductor. No matter how bright a mind a man has, or how good a student he is, he must wait for his promotion till the men ahead of him have been taken care of. Thus he does not advance in proportion to his ability, and when he finally does get beyond the retarding

influence of the brotherhood he is likely to be too old to be considered for the highest operating positions.

Since, under this method, there is no premium placed on ability, a man who has the natural characteristics of a good executive is liable to be discouraged by the long process and fall into a rut which gradually decreases his chances for promotion to the higher positions.

These conditions are greatly broadening the prospects for engineers in railway work. Provided a man is not too strongly wedded to his own profession, and is capable of rapidly grasping problems of an entirely new type, the chances for advancement in the operating department are exceedingly good, especially if his ability is measured against that of men who have not been educated to persistent trained thinking and investigation.

There are few men whose native or acquired ability to adapt themselves to new conditions is greater than that of engineers as a class. And the great problems which are constantly coming before the operating officials are of at least as great interest as those which are being encountered in the field of railway engineering.

Through Arch Bridges of Reinforced Concrete

IN EUROPE the development of reinforced concrete structures has been along lines such as would allow the greatest economy in materials of construction and not in labor, which is comparatively cheap. In America, until recently, the tendency has been to sacrifice and even waste material in order to cut down the labor cost of building forms and placing steel.

This at once explains why the through concrete arch has reached a much higher state of development in Europe than in America. The assumption of the greater cost of construction of this type as compared with the deck arch is without foundation in most cases, but as a rule American engineers are rather inclined to let the other fellow ascertain the real facts and figures, and then beat him at *his own game*, in the progressive development of the construction in question. We are just entering such a period as regards the use of the through arch, the economic features and advantages of which have been very forcibly brought to the attention of engineers by the very few structures of this character built in America. For this reason a treatment of the subject is timely and opportune.

The article on through arches of reinforced concrete appearing on another page in this issue, should prove of more than ordinary value to the bridge designing engineer, since it points out the difference between European and American practice, and give as well, illustrated detail descriptions of representative structures built both here and abroad. In view of the surprising lack of such information in American technical literature, we believe the article will stimulate interest in an important subject and lead to further study and improvement in the art.

Trestle Abutments

UNTIL quite recently the design of bridge abutments has not been given the attention it rightfully deserves. In many cases, especially with high approach fills and poor foundations, the cost of the abutments may be the greater part of the entire cost of the bridge. In spite of this, much attention has often been given to the design of the superstructure while the abutments have been designed in a few minutes by some rule of thumb, such as, the base shall equal 0.4 the height. This is nothing more than an economic waste and the cause of many unsatisfactory abutments and partial failures.

The general tendency at the present time is toward the development of abutments of such types as are of more general application, and at the same time possess many economic advantages over the older types. One of the most successful types of modern abutment is described on another page.

The greatest advantage of the trestle abutment is that by its use the enlargement of the effective waterway of a stream is encouraged rather than discouraged, as is the case where the ordinary gravity or reinforced concrete abutment is used. It should be extremely productive in lessening the number of bridges carried away during flood periods because of inadequate waterway.

The design referred to is about 90 feet high, and a glance at the photographs shows the immense saving of concrete effected with a resultant large decrease in the size of the footings, due to comparatively small dead weight carried.

The article referred to, while it is not an exhaustive study of the subject, contains much information which should prove invaluable to the railroad designing engineer. It gives an excellent idea of the progress made in a very few years toward perfecting these modern types and also the future possibilities as regards economic and esthetic development.

Location and Construction of a High Class Coal Road

SEVERAL distinct tendencies can be noted in the article on the St. Louis, Peoria & Northwestern Ry. on another page of this issue. Aside from the low gradients and curvature used, engineering progress is shown in the careful attention to drainage, and in the provision, in nearly all cases, of over or under railway crossings. Highway crossings were also avoided as far as possible, and especially on main highways or those having heavy traffic.

In the original construction of many railway lines the most economical waterways were provided, many of them being so designed that considerable head or pressure would be generated at high water. There are several disadvantages to such designs: (1) the pressure and velocity of water is liable to produce scouring and finally the destruction of waterway; (2) the cost of inspection and maintenance which will prevent washouts is high; (3) the water sometimes backs up on valuable private lands and results in heavy damage claims.

The waterways on the line in question have been made sufficiently large to amply care for the flood flow. Pipes and drains have been installed in many highways several hundred feet from the right of way, and every necessary provision made where the natural drainage is obstructed. Careful planning is shown in the location of practically all borrow pits on high ground where they will drain into natural waterways. Track ditches have been designed of sufficient size to carry surface water when necessary, these ditches being of more ample width and depth than used in a good deal of work, all these things showing the engineers realized that good drainage is the prime requisite of a good railway.

The amount of expense incurred in two of the overhead crossings is heavy, but one of these was located so that three

railways could be crossed quite close together. The investment in the proper signal protection of these crossings would have been large if at grade, and such an installation would have caused some interruption to traffic, whereas the overhead crossing does not, and the cost of stopping and starting the heavy coal trains would undoubtedly have been heavy.

Provisions for double tracking were made in locating the single track laid at a distance of 6½ ft. from the center line of the right of way, the second to be laid on the opposite side 6½ ft. from center line.

Bridge substructures were designed, in many cases, for double track. The saving is very marked in this work, provided the second track is added in a reasonable time. The cost of excavating beside an old pier, and building on an addition, is very high and also frequently introduces settling of the old foundation, with attendant danger, or at any rate additional temporary construction to support the old pier. Cost of form work is also decreased, per yard, in the larger foundations, and the cost of concrete is very materially reduced on account of the larger mass placed at a given location.

In the steel trusses, one side was designed as a center truss, or so that it could be easily strengthened to act as a center truss.

But for the use of straw to form a mattress for steam shovels, work would have been very seriously delayed in the high, clay and quicksand cut and fill at Sangamon river. Very good time was made in track laying, 45 miles being laid and nearly completely ballasted in the first 60 days after track laying commenced. A very ingenious adaptation of equipment to conditions for which it was not designed is shown in the narrow gauge dump cars mounted on standard gauge flats, for distributing rip rap after the permanent track had been laid.

Steel Design, Bay City Bridge

IN the article on the Bay City Bridge, G. T. Ry., in our issue of February, 1914, the design of the steel work was erroneously credited to H. B. Stuart, structural engineer. The steel work for this bridge was designed by J. G. Seyfried, formerly structural engineer of the G. T. Ry., and now engineer of the bridge department of Canadian Allis-Chalmers, Ltd.

Thornton Goes to England

AN English railway directorate is at present busily engaged in attempting to explain to the representatives of an outraged British railway managerial talent, its reasons for going to the United States for a general manager to handle the operating problems of the Great Eastern. More than passing interest has been created by the simple announcement: "Henry W. Thornton, general superintendent of the Long Island R. R., has been appointed general manager of the Great Eastern Ry. of England with offices at London."

The Great Eastern operates over twelve hundred miles with approximately eleven hundred locomotives, fifty-three hundred carriages (passenger cars) and twenty-seven thousand wagons (freight cars). The Long Island operates about three hundred and ninety-five miles. The promotion is therefore an unusual one aside from the aspect which is lent by the call to England. Lord Claude Hamilton, chairman of the Great Eastern's board of directors, makes no evasions in giving his reasons for the selection of Mr. Thornton, a comparatively young man, for his operating head. His principal reason involves the slow development of the men according to the English system, the only home-trained men available are beyond the age of best efforts before having attained the necessary experience and knowledge to assume great responsibility. Mr. Thornton's promotion through various positions on the Pennsylvania system is another case of an engineering education and an engineering experience culminating in an operating executive. He started as a draftsman in the office of the chief engineer of the Pennsylvania lines west of Pittsburgh and after having attained and held creditably the position of engineer of maintenance of way, was moved to the operating department as superintendent. Not the least of the requirements of Mr. Thornton's new position will be exemplified in the necessity for the exhibition of considerable diplomacy and he is well equipped in this respect.

After all it should be considered no greater a radical departure from common sense practice in promoting talented Americans to English positions, than in filling responsible positions in our own eastern railways with men trained in the far west, the objections will be shown to have been imaginary and upon Mr. Thornton's success will depend the dispelling of much prejudice.

—

In line with the above it might be pertinent to call attention to the fact that the condition in England which Lord Hamilton deprecates on account of its tendency to promote only by seniority, has prevented the making of efficient executive officers, is exactly what the American railways are contending with in securing operating officers, as pointed out editorially elsewhere in this issue. A lesson should be drawn by American railway brotherhoods and those with influence upon their actions, from the situation.

A Prospective Engineering Feat.

ONE OF THE most interesting of modern railway engineering projects is the prospective double-tracking of the Denver & Rio Grande through the Grand Canyon of the Arkansas. The admirable work in grade reduction and double-tracking which has been under way for some time, will find its consummation in the difficult problems offered by the canyon. The only feasible plans among those thus far considered call for an application of the double-deck principle.

Blasting out a road bed for the additional track through the narrow canyon has, of course, been considered, but there are few supporters of such a plan. The double-deck principle seems the more practical and it may be reasonably expected as the solution of the problem. A structure several miles long can be super-imposed on the present road-bed without seriously interfering with the efficient operation of the present single track and the resulting arrangement will have nearly all the capacity of the conventional double track. We say, "nearly all the capacity," for the reason that minor difficulties of operation are bound to arise as the result of such construction.

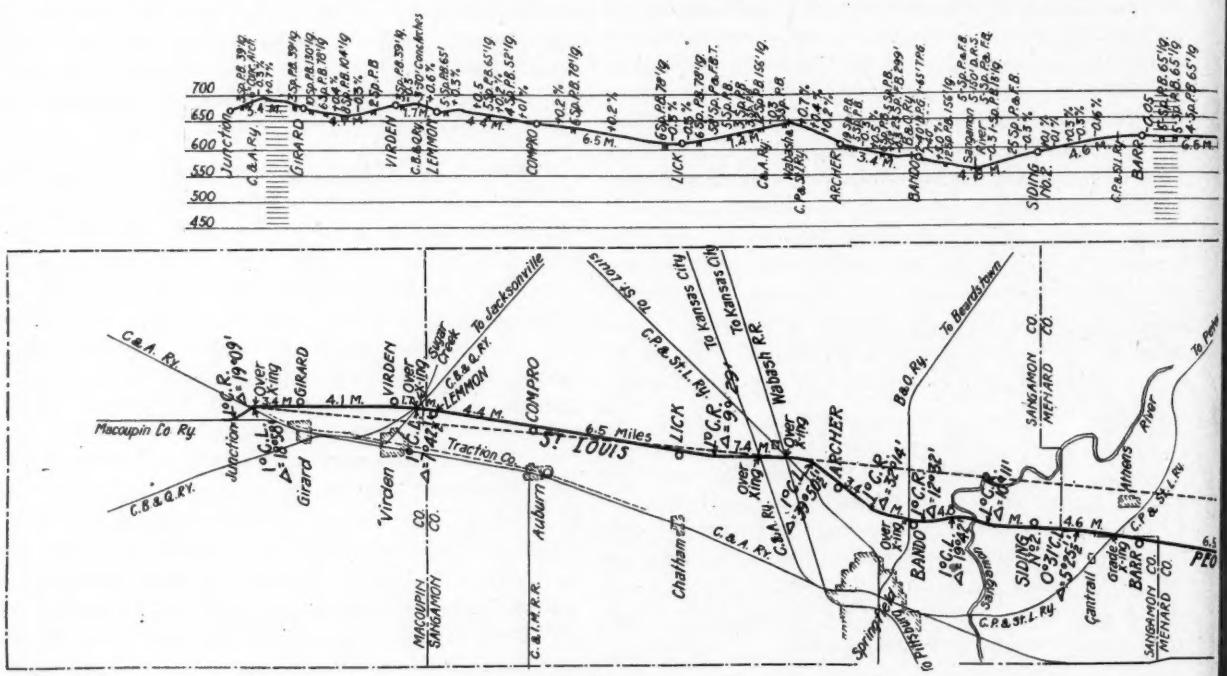
Concrete is being used to considerable extent in the construction of coal pits for the storage of coal under water to prevent spontaneous combustion, which has always been a source of danger where coal is stored in large quantities. A fire once started in such a pile is very difficult to put out, and even then the losses are heavy. When concrete pits or tanks are used the coal can be flooded, thus preventing loss by fire and oxidation.

St. Louis, Peoria & North Western Ry.

A new 95-mile coal road on which a low percentage of very light curvature was combined with easy gradients, giving an exceptionally high-class line.

A new railway has recently been put into service in southern Illinois which is notable for the amount of money invested to prevent grade crossings, for the combination of a low gradient with a low percentage of very light curvature, and for the general excellence of the roadway which was particularly designed to provide drainage fully adequate to the needs of the topography and of roadbed.

The St. Louis, Peoria & North Western Ry. is a new coal road recently put into operation by the Chicago & North Western Ry. Starting from Peoria, the former terminus of the Peoria branch, the line runs south and a little west, its southern terminus being a junction with the Macoupin County R. R. The latter road was originally built to connect a string of mines to supply the C. & N. W. Ry with coal, and until recently the entire output of these mines had to be shipped north over foreign roads.



Alinement and Profile, St. L., P. & N. W. Ry.

The new line is located through a very rich farming district, the cost of right-of-way being very high in a number of places. The material moved in embankments and cuts varied from a rich black loam to clay, sometimes mixed with sand, gravel, and in one case only, solid rock. The line is single track, located to one side of the center line of right-of-way so that a second track can be added without lining over the first track. In some cases where the cut yardage overbalanced the fill yardage, the grade was completed for the second track. Provision was made for second track in all permanent substructure and superstructure designs, and in some cases bridge foundations were built for two tracks.

As shown on the profile, the ground surface is rolling, but is not sufficiently rough to prevent a low grade and low curvature line without moving an excessive yardage of cut and fill. Some of the largest fills were made to eliminate grade crossings, where the topography would have necessitated only a fraction of the yardage actually used.

Most railway locations in the past have had as some of the important governing points, cities of greater or less importance. The effect is now shown in the large number of small towns along old railway lines, towns which will never be of great importance, due to natural conditions. But to reach these towns in original location, the curvature and sometimes the gradients were increased considerably.

Trying to adjust a new location line to small towns is not now being frequently attempted, especially in location in the middle and western states. Location lines are adjusted to fit topographical, and other conditions considered of more importance. Stations are designated and depots erected on the line, which, although located in the country when the line is built, gradually become towns of greater or less size. In general the size of such towns developed after the railway is located, will compare very favorably with the size of towns on older lines, where considerable expense or difficulty was encountered in reaching them.

The line of the St. Louis, Peoria & North Western Ry. is notable because although located in the populous state of Illinois, it reaches no large city. Even Springfield, the capital, is disregarded, although the line as located is within two miles of the outskirts of the city.

Points Governing Alinement.

Beginning at Kickapoo Junction the alinement to the Illinois River crossing was governed partly by topographical features, but more especially by the large number of existing railway lines, and also by the most advantageous locations for the bridges across the Kickapoo and Illinois rivers. In this distance of less than nine miles, there are seven railway crossings.

From the Illinois River, location was fitted to the topography until striking the long tangent shown, where there were no particular difficulties, the country being flat. This tangent, except for one short 30-minute curve, is 20.6 miles long.

Two changes in the general alinement were necessary in crossing Salt Creek. There was a high ridge to the north, and the line was diverted to cross this ridge at the lowest point, just before

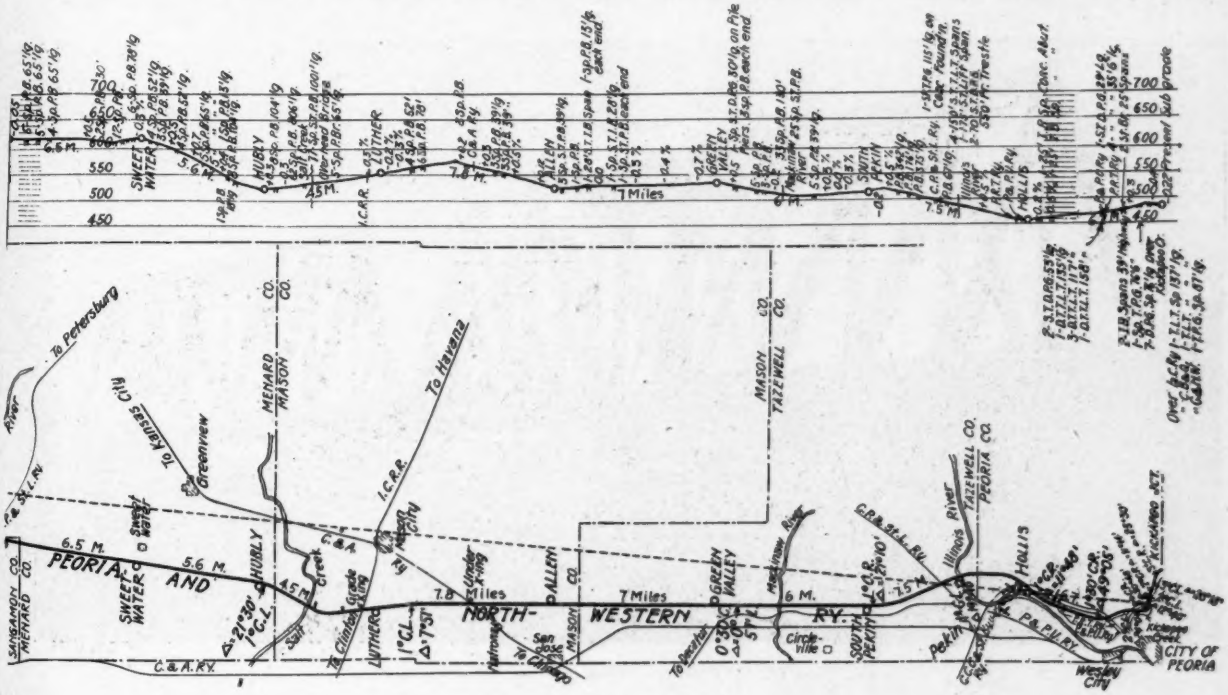
crossing the Illinois Central R. R. at grade. The next governing point was the advantageous location of the Salt Creek bridge, which necessitated another change in alinement.

After crossing this creek the line is nearly straight, there being no difficult work in this stretch. The Chicago, Peoria & St. Louis Ry. is crossed at grade, in this tangent, the southern point of which was determined by the desired location of the bridge over the Sangamon River. Beyond the crossing over the Baltimore & Ohio R. R., this line veers sharply to the left and crosses over the Wabash R. R., the Chicago, Peoria & St. Louis Ry., and the Chicago & Alton Ry. The point near where the first two railways cross at grade was set as an arbitrary point where the length of the high fill between structures, made entirely from borrow, could be greatly lessened. This overhead crossing is a feature of the work, requiring in fill and approaches 450,000 yds., all of which it was necessary to take from borrow pits. The land at this point was a very valuable apple orchard, and yet it was necessary to buy right-of-way about 660 ft. wide to provide sufficient borrow material.

The gradient of the beginning of the line was established by the C. B. & Q., overhead crossing and by the hills on the banks of Kickapoo Creek. These hills are solid rock, and the grade on the approaches to the bridge are the maximum ruling grades, + 0.5% south and + 0.3% north. The bridge is located far above high water.

The next overhead crossing made is over the Peoria Railway Terminal, and the Peoria & Pekin Union Ry. The gradient to the south is eased off to 0.2% to obtain the required height for this crossing, and from this point the grade is level. South of it is a short stretch of — 0.5% and — 0.3% with considerable fill.

A second crossing of the Peoria and Pekin Union and the Peoria Railway Terminal is at grade, with level approaches on either side. The next ruling point was the required height for the Illinois River bridge. North of the bridge across the bottom, a fill from 10 to 15 feet high was found necessary on account of



Continuation from Opposite Page.

The next ruling point in the alinement was the crossing over the C., B. & Q. Ry., where, as shown on the map, the line avoids a crossing over a small branch line running to the town of Virden.

The crossing over the C. & A. Ry. is at low point in the profile of that road. The location line was then converged into the Macoupin County R. R., its destination, as rapidly as the ruling gradient permitted.

The Macoupin County R. R. is a possession of the C. & N. W. Ry., built a number of years ago. It developed considerable coal traffic which before the completion of the P., St. L. & N. W. Ry., was delivered to the Chicago & Alton Ry., and the Chicago, Burlington & Quincy R. R. This coal traffic has now been diverted to the new Peoria, St. Louis & North Western Ry., and over the Peoria division of the Chicago & North Western Ry., reaching the main line of the latter at Nelson, Ill.

The line has been designed and built strictly as a coal road, although considerable local business will undoubtedly develop.

Points Governing Gradient.

The maximum gradient north, which is against loaded trains, is 0.3%, and the maximum grade south, against empties, will eventually be 0.5%. A grade of 0.7% and one of 0.6% were put in temporarily, but will later be cut down to 0.5%.

The gradient of the beginning of the line was established by the C. B. & Q., overhead crossing and by the hills on the banks of Kickapoo Creek. These hills are solid rock, and the grade on the approaches to the bridge are the maximum ruling grades, + 0.5% south and + 0.3% north. The bridge is located far above high water.

The next overhead crossing made is over the Peoria Railway Terminal, and the Peoria & Pekin Union Ry. The gradient to the south is eased off to 0.2% to obtain the required height for this crossing, and from this point the grade is level. South of it is a short stretch of — 0.5% and — 0.3% with considerable fill.

A second crossing of the Peoria and Pekin Union and the Peoria Railway Terminal is at grade, with level approaches on either side. The next ruling point was the required height for the Illinois River bridge. North of the bridge across the bottom, a fill from 10 to 15 feet high was found necessary on account of high water. The grade is level till reaching the approach of the bridge, which is + 0.45%. The bridge was located high enough so that the lowest point of the floor will clear maximum high water; the grade on the bridge is + 0.3%, which continues to a summit in the hills to the south.

From this point the gradient was governed by topography, no features or heavy work being necessary to obtain very easy gradients. Short approaches of + 0.25 and — 0.2% carry the tracks to a sufficient height for the crossing over the Mackinaw River. The next ruling point was the crossing under the Chicago & Alton Ry., on which the grades are well below ruling.

The Illinois Central R. R. is crossed at grade, this involving no extra work, as both railways are located on low fills close to a summit. North of Salt Creek is a high hill. A high crossing was desired here, but even then it was necessary to make a cut 30 feet deep at the summit. The approach from the south is a long piece of + 0.3%, carried over the structure across Salt Creek, with a maximum fill of 15 feet at the south abutment. Nothing interfered with the location of this line according to the topography for a considerable distance south of Salt Creek, the next ruling point being the grade crossing of the Chicago, Peoria & St. Louis

Railway, with a + 0.3% approach on the south and a — 0.16% on the north.

The Sangamon River is situated in the roughest country along the line, and this section required the heaviest excavation. The height of the bridge was determined by the high ridge to the north. There is a + 0.3% approach about three miles long from the north, and a + 0.45% approach one and one-half miles long from the south.

The B. & O. R. R. is crossed overhead, but due to its location in a deep cut, little extra provisions were necessary for this crossing.

The feature of the entire location is the triple overhead crossing of the Wabash R. R., the Chicago, Peoria & St. Louis Ry. and the Chicago & Alton Ry. As mentioned previously, the alinement was chosen to cross two of these roads near where they intersected at a grade crossing. From this point to the crossing over the Alton is about 4,200 feet. Disregarding these overhead crossings, the economical line at this location would have followed close to the natural ground surface The fill is 26 feet high at the

maximum points and will average about 20 feet; all of the material was hauled in from borrow pits located on the nearby summit, which required considerable haul, however. The approach to the overhead crossing is 2,500 feet of + 0.7 from the north (later to be reduced to 0.5%); and 9,200 feet of + 0.3% from the south. The latter grade, however, is approximately the natural grade for about 2,000 feet of this distance.

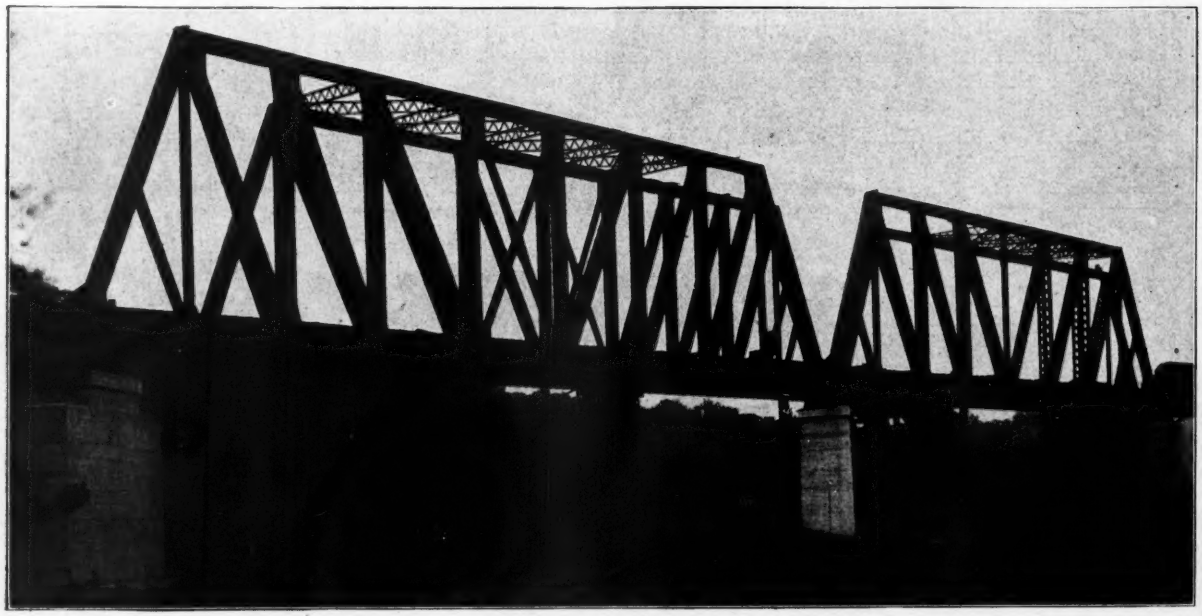
Topographical features governed from this point and a very economical line was obtained without heavy excavation or fill until reaching the overhead crossing of the C., B. & Q. Ry. This necessitated a very high fill, at Sugar Creek, which is in a gully and runs under the roadbed through the triple arch, illustrated herewith. The maximum fill at the arch abutments is 45 feet. The approach from the north is + 0.6% and the run off to the south is — 0.3%, whereas a grade of about + 0.2% from the north would have sufficed if there was no overhead crossing.

The overhead crossing of the C. & A. Ry. was located at a low point in the profile of the latter, but even then required a large amount of extra embankment. Some latitude was allowable in the point of interstion with the Macoupin County Ry., although the farther south the line was carried the greater the length of line uselessly duplicated. The approach to the overhead crossing of the C. & A. Ry. from the north is a + 0.7%, and from the south abutment the gradient is + 0.3%, the ruling grade. Thus the connection with the Macoupin County Ry. was run in as quickly as possible without exceeding the ruling grade.

On the whole, the profile as well as the alinement seem to have solved all the problems in an excellent manner, consistent with the high class line required.

Structures.

Kickapoo Creek Bridge.—The longest structure on the line is the bridge over Kickapoo Creek and Perry avenue, about two miles west of Peoria, Ill. This bridge is 1,070 feet long, ranking ahead of the Illinois River bridge, which has a length of 915 feet. The Kickapoo Creek bridge consists of thirteen spans, as follows: Two 39-foot through I-beam spans over Perry avenue; one through plate girder 76 feet, 6 inches long; seven deck plate girders 76 feet long over Kickapoo Creek; one through latticed span 137 feet long over the Iowa Central R. R.; one 137-foot through latticed span over the C., B. & Q. R. R., and one through plate girder 87 feet long over the C. & N. W. Ry.



Skew Truss Spans, Kickapoo Creek Bridge. (Incompleted.)

Abutment No. 1 is skewed at an angle of 27 deg. 24 min. 36 sec. with center line of bridge. The angle of skew for pier 2 is also 27 deg. 24 min. 36 sec.; for pier 3 is 30 deg. 57 min. 33 sec., and for pier 4 is 34 deg. 15 min. 5 sec. These piers are skewed to approximately parallel the three lines of railway.

Piers 5, 6, 7 and 8 are at right angles with the bridge tangent. Pier 9 is located approximately at the center of the Kickapoo Creek channel and is skewed at an angle of 45 deg. to correspond with the general direction of the channel.

Piers 10 and 11 are perpendicular to the center line, while piers 12 and 13 and abutment 14 are skewed at an angle of 41 deg. 33 min. and 22 sec. with the center line.

All footings are on solid rock about 12 ft. below the ground surface. The masonry is composed of mixtures as follows: Copings, 1-2-4; body, 1-3-5; footings, 1-3-6. The coarse aggregate was crushed stone.

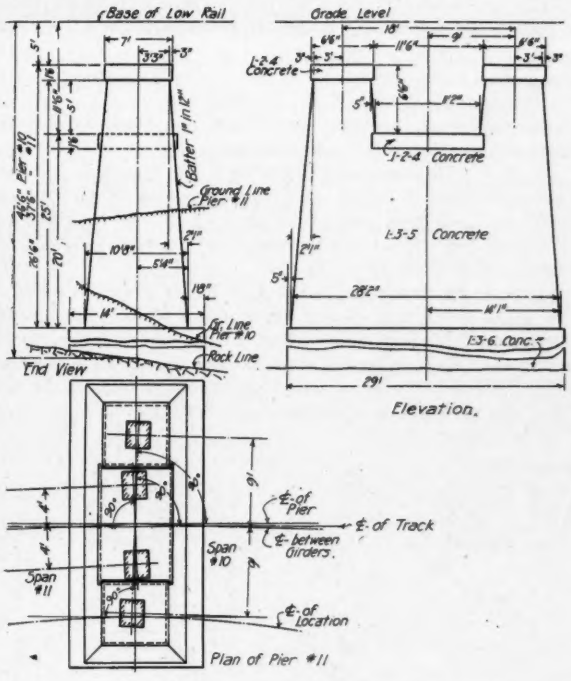
All piers are rectangular except No. 9, which is located in the center of the channel. This pier has a starkwater reaching from footing to coping with a batter of 3 feet 11½ inches in a height of about 33 feet 6 inches. The batter on face of piers is 1 in 12.

The live load used in the design of this bridge, as well as all the others on the line, was Cooper's E-55. The stress in concrete is figured at 500 lbs. per sq. in. The bearing being on rock, it

was not necessary to spread the footings. The saving in substructure concrete for a deck as compared with a through span is shown in piers 10 and 11, and is considerable, even for girder spans. The design of the piers works out nicely, since through girders must of necessity be spaced on greater centers, and the pedestals supporting them easily clear the deck girders. (See illustration.)

The angle of skew made a complicated design necessary for the south abutment. It is a single-wing abutment, or a combination of an abutment and retaining wall. The wing is nearly parallel with the center line of track, and retains the slope of embankment. The face of the abutment is 72 feet 2⅝ inches wide, and has two construction joints. These are not located at the third points, but were made at the intersection of the angular faces of the back wall. This abutment is designed and constructed for two tracks. The wing or retaining wall portion is not completed, but is to be extended, as shown, when the second track is added. The back wall is plain concrete, poured monolithic with the rest of the abutment. The average soil pressure on the abutment is 3,300 lbs. per square foot. The maximum is 6,600 lbs.

Both abutments are built to accommodate double track. All



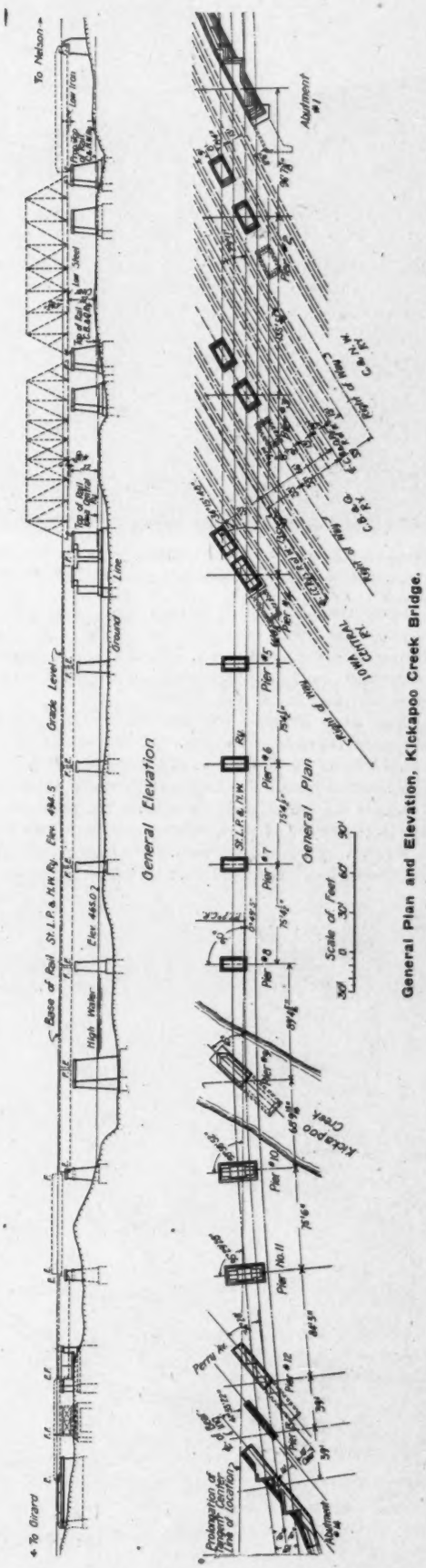
Pier for One Deck and One Through Girder Span.

piers, however, were designed to be added to, and were constructed for single track only. Future center trusses and girders were designed for double track.

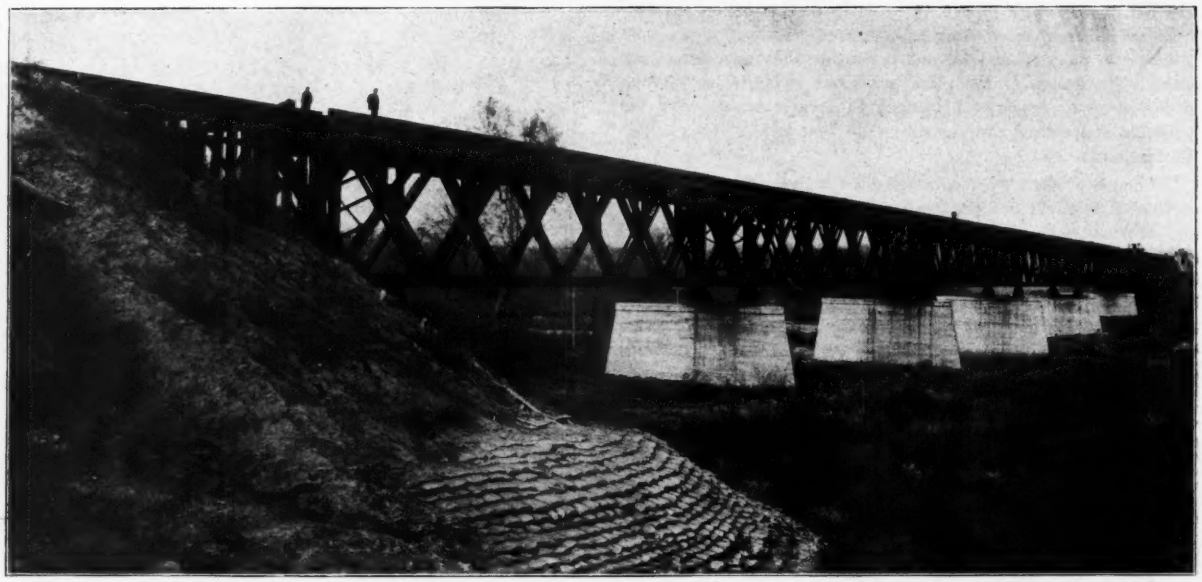
Illinois River Bridge.—The bridge over the Illinois River consists of four 150-foot through truss spans, one 175-foot lift span, two 70-foot deck girders and a 550-foot trestle approach. The steel work is single track, with provision for easy alteration for double track. Foundations are all for double-track bridge. A complete description of this structure appeared in the October, 1913, issue of *Railway Engineering*.

The reason for constructing the Illinois River foundations for double track is that cylinder piers were used. Comparatively little extra expense is involved in spacing the cylinders for double track. Spacing for single track would have necessitated the future addition of a third cylinder to each pier, thereby greatly increasing the cost.

Over Mackinaw River and Salt Creek the bridges each have



General Plan and Elevation, Kickapoo Creek Bridge.



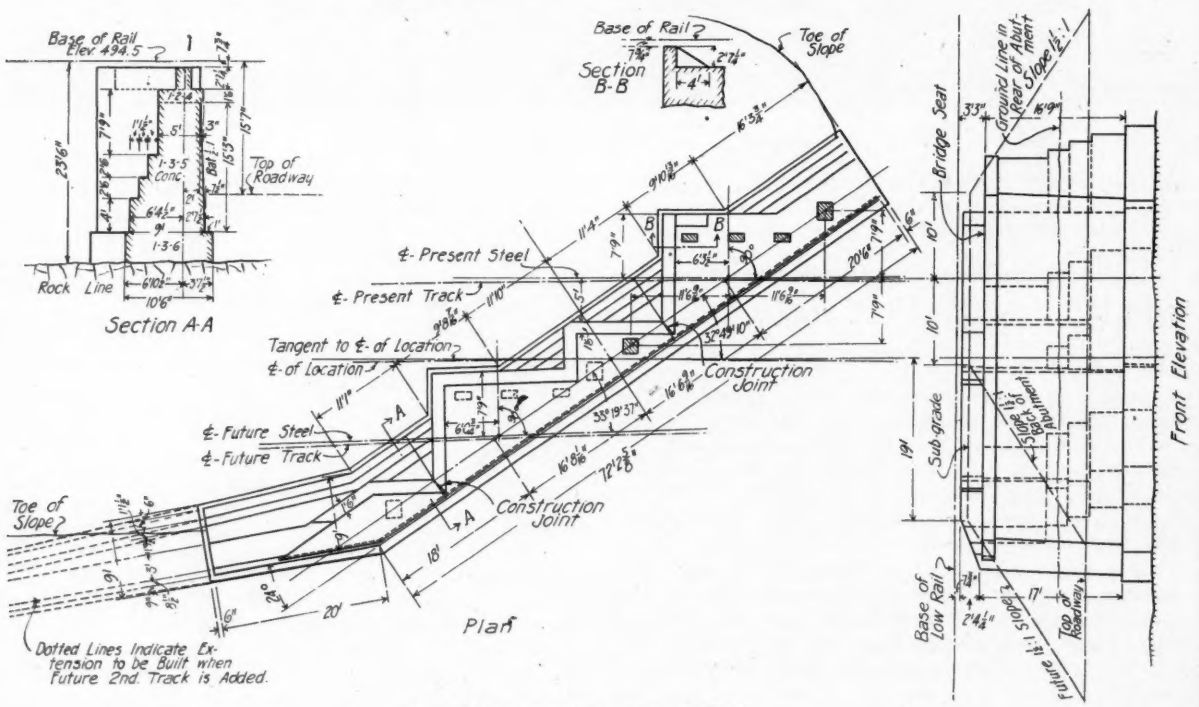
Sangamon River Single Track, Deck Truss Bridge with Double Track Foundations. Note Rip-rap, Which Is Composed of Bags Containing 1 to 8 Concrete.

one 130-foot through rivetted latticed span, with pile bridge approaches. The steel spans rest on cluster pile piers, all foundations built for single track. Sugar Creek is crossed on a pile bridge with trestle approach, and Cantrall Creek necessitated a 25-span pile and frame bent bridge.

Sangamon River Bridge.—The structure over Sangamon River presents some interesting features. It consists of five trestle approach spans on the north end, and five 150-foot deck riveted spans on concrete piers. The height of the track above the river made possible the use of deck spans, with the resultant decided decrease in the height of piers, which would have been necessary had a through structure been used. The photograph gives an idea of this saving. The dead load on supporting piles is also very considerably less than would have been necessary with the high piers necessary for a through span.

C., B. & Q. R. R. Crossing.—Over the C., B. & Q. R. R. is a deck girder structure, consisting of two deck plate girder approach spans on one end, one deck plate girder approach span on the other, and a through plate girder with minimum floor depth immediately over the C., B. & Q. R. R. tracks.

C. & A. Ry. Crossing.—The C. & A. Ry. is crossed overhead at an angle of 41 deg. 58 min. on a single 65-foot plate girder. The abutments are 30 feet 5¼ inches from base of footing to top of coping. Both abutments have the same dimensions throughout. From center to end of abutment the dimension is 79 feet 6 inches on the side where the angle with the C. & A. Ry. is



South Abutment, Kickapoo Creek Bridge.

138 deg. 2 min. On the opposite side this dimension is 26 feet—the angle being 41 deg. 58 min.

The abutment is really a combination abutment and small culvert. As shown in the section, the culvert opening is 3 feet wide by 4 feet high, square on the bottom and rounded to a radius of 1 foot 6 inches on top. The bottom of the culvert is at the top of the footing, the latter being designed at the elevation of the bottom of track drainage ditches.

The average soil pressure on the abutment is 3,500 lbs., the maximum 5,500 lbs. The average pile loading is 28,000 lbs., with a maximum of 36,500 lbs. under toe of abutment. The length of one wing of these abutments was shortened materially by building cross walls nearly perpendicular to face of abutments, extending back far enough to cut off the natural slope of 1½ to 1. This design resulted in marked economy, as shown on the plan by the line marked "natural 1½ to 1 slope."

Sugar Creek Arch.—The triple arch at Sugar Creek is of plain concrete, closed spandrel type, with spans of 30 feet each. The bars, shown in the section, were added as temperature reinforcement, in intrados only, and were not considered as taking any strain from the load, unless it is caused by unequal settlement of the foundations. The footings, 2 feet 6 inches thick, also have reinforcing to take care of unequal settlement. Footings are founded on piles spaced 3-feet centers longitudinally and 2 feet 9 inches transversely to piers and abutments. In order to provide sufficient piles to keep below a maximum of 62,000 lbs. pressure per pile in the piers, it was necessary to spread the foundations. Four offsets were made, 1 ft. 6 in. wide, offsets at 2 ft. 6 in. heights. The maximum pressure on abutment piles is 59,000 lbs.

In the wing abutments the extradosal curve is carried down to a point opposite the center of the intradosal curve; the continuation of the tangent to this curve forms the back of the

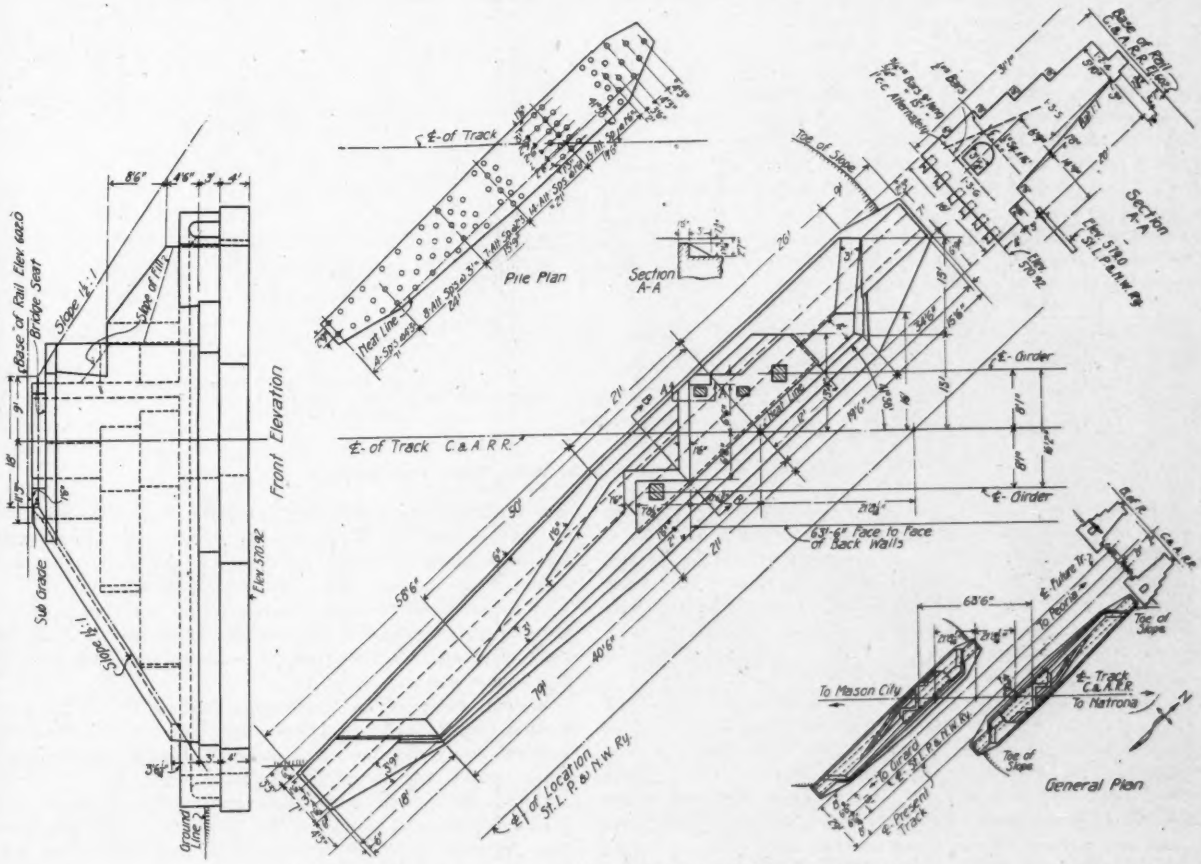
View of Combination Abutment and Track Ditch Culvert, C. & A. Ry. Overhead Crossing.

abutment. The thickness of abutment at footing is only 10 feet; the short 30-ft. spans not developing a very great thrust.

The intrados of each arch ring is a semi-circle having a radius of 15 feet, while the extrados is circular segmental with a radius of 22 feet. The centers of these radii are at points which give a thickness of 2 feet 2 inches at crown.

Expansion joints are provided in the parapet above the center of each pier, at which point drain pipes 5 feet long were inserted to drain off the water flowing down the extrados of arch ring, thus also preventing seepage of water through the expansion joints. The latter are provided with keys as shown in the section, and the concrete is separated by three layers of felt.

Horizontal reinforcing is provided near the faces of the spandrels, bars on one-foot centers, for temperature strains only. The parapet is reinforced by upright bars on one foot centers, parallel to inner faces of parapets. All bars in the parapets and spandrels



Plan and Sections of Combination Abutment and Culvert for Track Ditch.

are ¼-inch corrugated, while those in the intrados and in the footing are ½-inch corrugated.

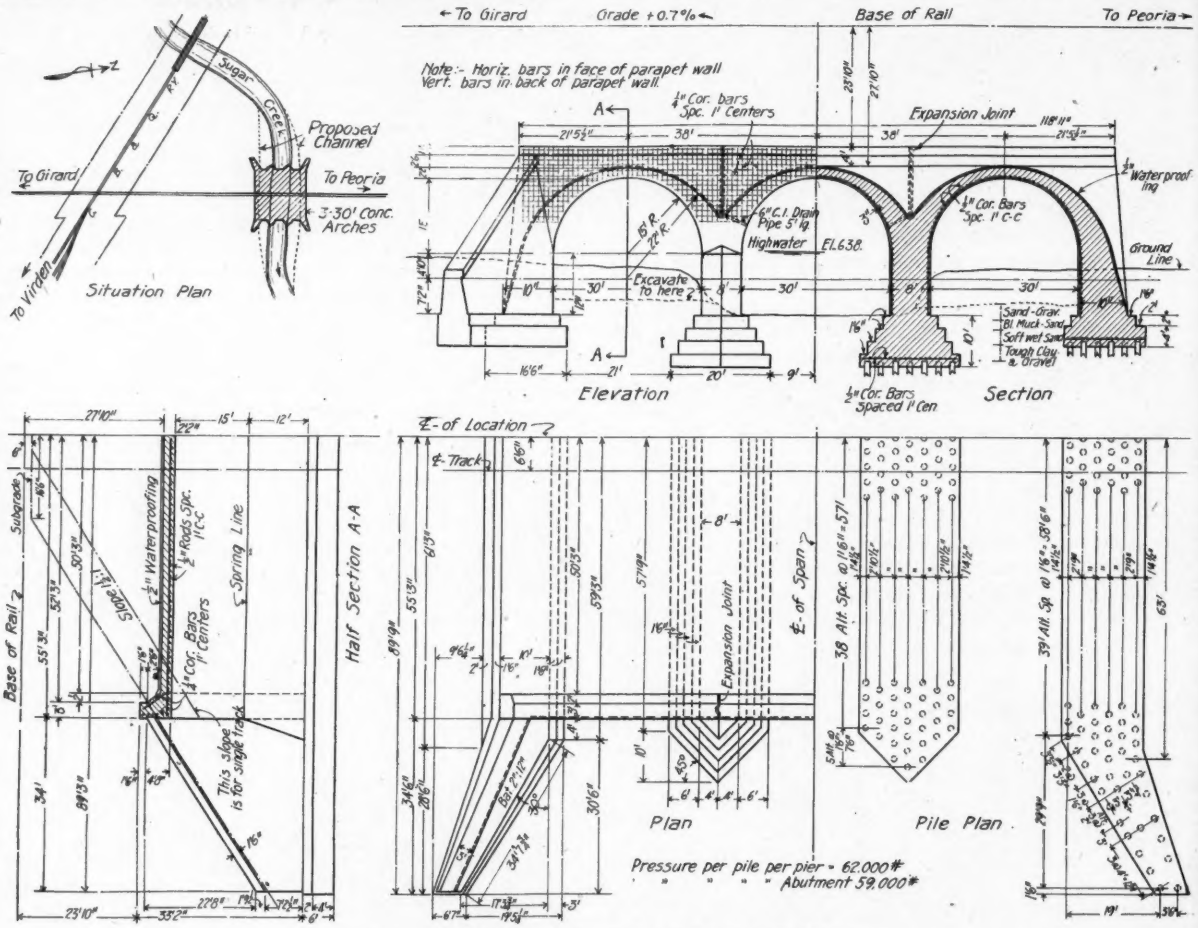
The triangular pointed piers, surmounted by flat pyramidal tops, serve as starkwaters and also improve the appearance of the structure by breaking up the flat surface.

The arches are filled with gravel ballast between spandrels, and the arch rings have a thickness of 2 feet 6 inches at crowns.

Concrete Box Culvert.—The culvert shown in one of the illustrations is a standard concrete box culvert with square 6x6-foot opening. The top is reinforced in two planes, 3½ inches from top of slab, and 2½ above bottom of slab, the latter being 1 ft. 4 in. thick. Transverse reinforcing consists of ½-inch square steel rods on 4-foot centers in top, and 3¼-inch centers in bottom. There are two longitudinal bars at each side in top of slab, while there are nine bars in the bottom. Every 4 feet there are provided stirrups from bottom to top reinforcing, as shown in section.

The reinforcing in the bottom is similar to that in the top, but more longitudinal bars are used near bottom of footing slabs. Concrete in the cover slab, walls and wings is a 1-2-4 mix, with crushed stone passing a 1-inch ring, and with all crusher dust removed. The footings are of 1-3-6 concrete with stone passing a 2¼-inch ring.

Adams Street Viaduct.—The Adams street viaduct is a deck plate girder, concrete slab floor structure. The columns are of structural steel and are located on piers whose center line is skewed to the direction of the highway. The slabs are 11 inches thick, with reinforced parapets 1 foot 3 inches high. Slabs were poured in ground molds and placed with a derrick. Asphalt was used as a surfacer between girder tops and slabs. The reinforcing details are shown in the plans herewith. Concrete is a 1-2-4 mixture with 1-inch stone devoid of crusher dust. The structure was designed for a concentration of 60,000 lbs. on each of two axles spaced 6-foot centers. Impact was figured by the formula $I = \frac{L^2}{L + D}$. The maximum tension in steel is 12,000 lbs. per square inch, and maximum compression in concrete is 660 lbs. per square inch.



Half Plan and Sections of Sugar Creek Triple Arch Bridge.

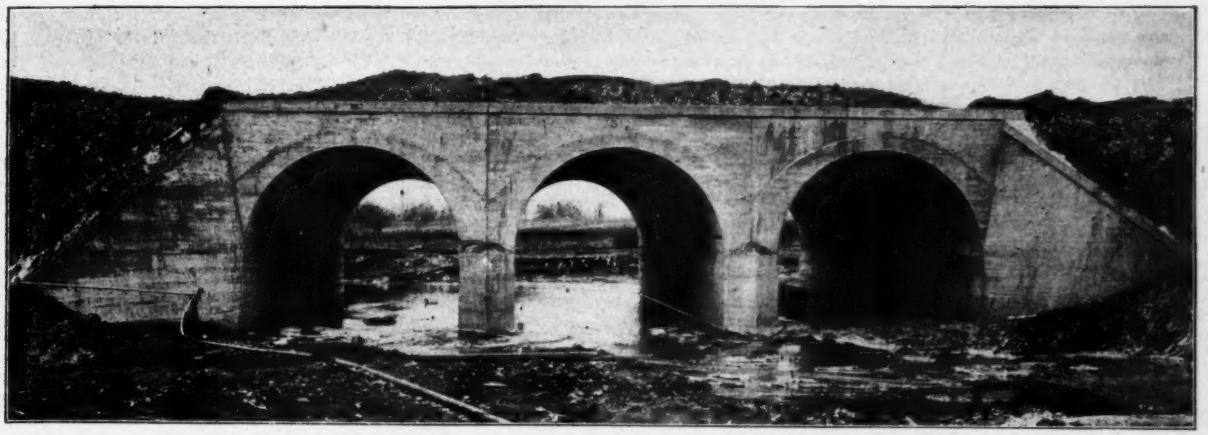
Water Supply.

Test drilling showed the necessity, in some cases, of obtaining surface water for engine use, as water was found to contain sulphur from the underlying coal. At Lick Creek a reservoir with 15,000,000 gallons capacity was made by building a small dam consisting of a sheet piling box 3 feet high, filled by hand, with a top covering of stone; 80,000 cubic yards were also excavated from this reservoir by drag line and the material was wasted. The drainage area is 100 square miles.

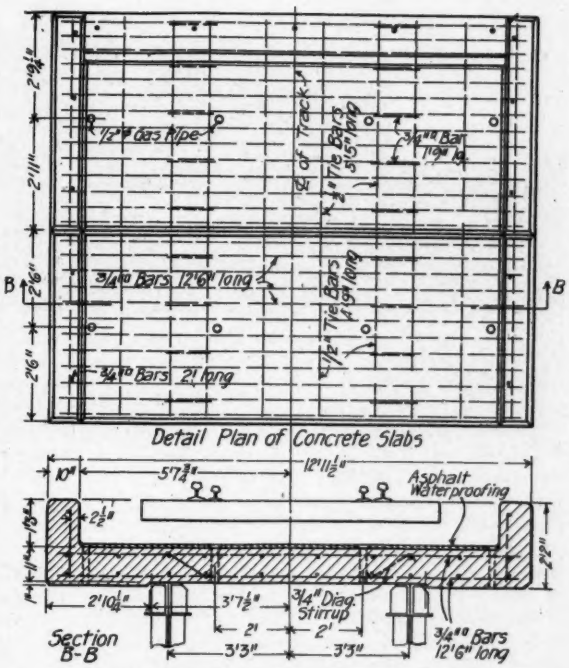
At Sugar Creek two more reservoirs were constructed by excavating with a drag line, the material being used to build the track embankment. The drainage area for these reservoirs is fifty square miles.

At South Pekin and Luther, Chicago Bridge & Iron Works combination elliptical and funnel bottom tanks are installed. Water of sufficient purity was found at a depth of about 80 feet in water-bearing gravel, and deep wells were sunk.

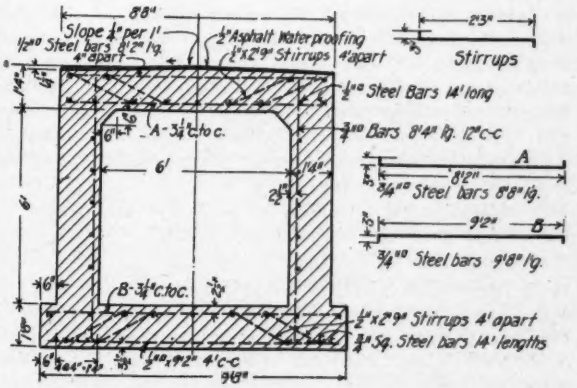
The standard wooden tank has a capacity of 70,000 gallons, and is mounted on steel posts. A Fairbanks-Morse 12x7x12 steam pump, operated by a 35 h. p. engine, furnishes water to the tank through an 8-inch Universal cast iron pipe.



View of Triple Arch Concrete Bridge at Sugar Creek.



Concrete Slab Floor, Adams St. Bridge.



Section Standard 6 x 6-Ft. Concrete Box Culvert.

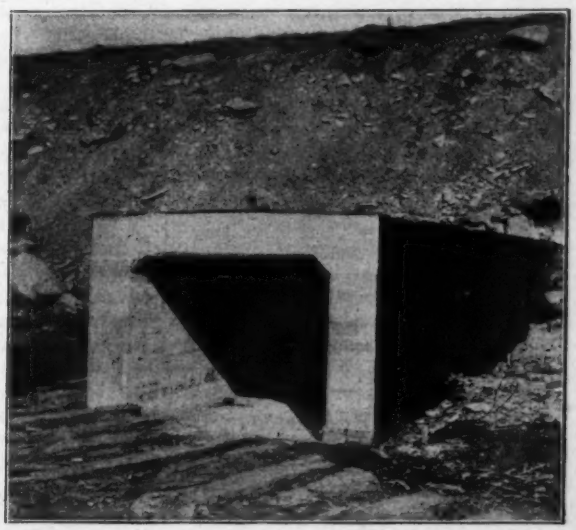
Construction.

Grading.—A large amount of material was excavated by drag line. In several places very long hauls were made from borrow pits in order that the latter could be located in hills where they could be easily and effectually drained. Deep, capacious ditches are provided wherever the natural drainage is intersected, and drain pipes were placed in highways wherever the new fill obstructs the highway ditches.

North of the Illinois River the fill was built mostly by a drag line. Sufficient material was not obtained in this way, however, and the top was put on by hauling in rock from the hills to the north. The only serious sink hole encountered on the line is in this section, and the grade is still settling at this point. The toe of fill was widened and it is now designed to keep on filling the sink until the embankment settles to a solid foundation. This fill is riprapped, on account of the waves which are caused by the winds, when the bottom is flooded.

In the next heavy work, north of Hollis, it was intended to use a drag line. The earth, however, proved too soft to support a machine on rollers and was not wet enough to provide water for a scow. The filling was therefore made from borrow, loading with a steam shovel, hauling to dump by a dinky engine, and dumping from four-yard dump cars.

The Chicago, Peoria & St. Louis Railway was depressed 13 feet, the excavated material being wasted. The filling for the overhead track embankment was strippings from the gravel pit, necessi-

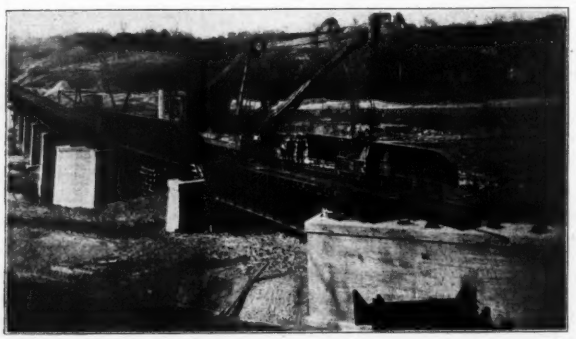


View of 6 x 6-Ft. Box Culvert Under High Fill, North of Illinois River.

tating a rather long haul. A similar dump car to that described above was used. The C., P. & St. L. Ry. was first detoured over a temporary track.

The Chicago & Alton Railway was raised 22 feet, the trains being detoured while the grade was built. It was necessary to haul material from a borrow pit in a hill one mile west on the C. & A. Ry. The equipment was the same as for the C., P. & St. L. Ry. work.

Considerable trouble developed in the excavation and fill north of the Sangamon River. The material encountered was soft, water-bearing blue clay seamed with quicksand. The steam shovel was headed south and work was therefore started at the north, which was the upper end of the cut. This method might have worked out in a dry cut and during dry weather, but the force soon got into a water pocket and had to start a shovel in from the south end to drain the pocket. Much trouble was experienced on account of the soft bottom in the cut, and also on the fill made with the excavated material. Straw was bought by the carload and laid as a mattress under the tracks. The contractors bought all



Placing Girder at North End of Kickapoo Creek Bridge.

the straw in the vicinity and then shipped in forty or fifty cars of baled straw. The fill constantly slid away and finally slid clear off the right of way, which is very wide at this point. The principal trouble seemed to be caused by the sand layers running out from under the clay. The cut was 45 feet deep and the fill about 40 feet high. It was necessary to take out one extra 16-foot shovel cut on each side on account of the unstable material.

The fill at Sangamon River was protected by riprap of sandbags filled with a weak concrete composed of 1 to 8, with gravel. This provided a novel but effective protection, the bags still being in place as shown in one of the photographs.

Although located in a 12-ft. cut, the Beardstown highway was depressed 20 feet further to make it an under crossing. The excavation totaled 30,000 yards, which was put on second track fill to the south.

The triple crossing over the C., P. & St. L. Ry., the Wabash and the C. & A. Ry. required a fill containing 450,000 yards. The material was hauled a maximum of three miles in 4-yard dumps, and unloaded from a trestle. The right of way for both the borrow and the fill was through a young orchard. Two miles of right of way cost $60,000.

Another overhead crossing, above the C. & A. Ry. and the Illinois Traction System, required 325,000 yards of borrow, but the haul was much shorter than in the one mentioned above.

Structures.—In general, steel was erected on trestle supports. High trestles were a combination of pile trestles and frame bents, the frames being usually built from about the ground surface up. This method shortened the required length of piles and consequently their cost. For short bridge spans, I-beams were used temporarily until the permanent girders arrived.

On the Kickapoo Creek bridge the trusses were erected on false work. The girders, however, were placed in permanent position on the concrete piers by a derrick with a long boom. The floor system was built in rapidly and track completed over each span before the next was placed.

At the Sangamon River deck truss bridge, pile trestle was built up to the height of the low steel, with frame bents above. The steel trusses were rested on the pile trestle caps between the frame bent uprights. After the structural steel work was completed, the frame bents were very easily removed.

The traction driver was lowered down the embankment and drove the first two bents from the ground. Stringers 12x12 inches square by 30 feet long were then placed on the bents, and the pile driver was jacked up and blocked up till it could be placed on the structure. The rest of the piles were then driven with the driver operating on 12-inch stringers on the partially completed structure. This procedure was necessary on account of soft ground and the liability of high water. A gang of carpenters followed close behind the driver and put up the timber bents and decked the structure.

Track Laying.—Track laying started at South Pekin the middle of October, 1912, and 45 miles of main line were laid by January 1, 1913, and in addition about twelve miles of siding. At this point the uncompleted grade at Sangamon was reached,

Combination Type of False Work Used at Sangamon River.

where trouble was being encountered on account of slides in cut and on fill.

After laying track to Allan the track machine returned to South Pekin and laid to the gravel pit, three miles north. Ballasting was commenced immediately by a second gang of the track contractors. An average lift of 6 inches was given to all track laid. Considerable trouble was experienced with ballast freezing. Ballast was unloaded just as soon as possible after being delivered, sometimes working the company's unloading gang till 12 or 1 o'clock at night. Roger ballast cars were used and frozen chunks were, of course, bothersome. A portion of the gravel pit was not stripped and huge chunks of frozen dirt and clay were pulled down. These had to be broken up by the shovel dipper and loaded by chaining to the dipper teeth. Work was pushed fast enough so that the face of the cut in the pit never became seriously frozen.

Track was all laid by Roberts Bros., of Chicago, with a track machine. The same contractors did the ballasting, giving track two raises. Twelve inches of ballast was required under the ties. Ballast was fine, clean gravel. The gravel was not quite coarse enough to make the best ballast. Rogers ballast cars were used in 1912, but a change was made to Haskel & Barker side swing door cars and a Lidgerwood unloader in 1913. The track is laid with 90-lb. A. R. A. rails, with 18 to 21 ties on tangent, and 19 to 22 ties on curves. The number of ties per rail length depends on the size of the ties.

The ballasting crew was laid off about February 1, and the track laying gang was laid off March 1, 1913.

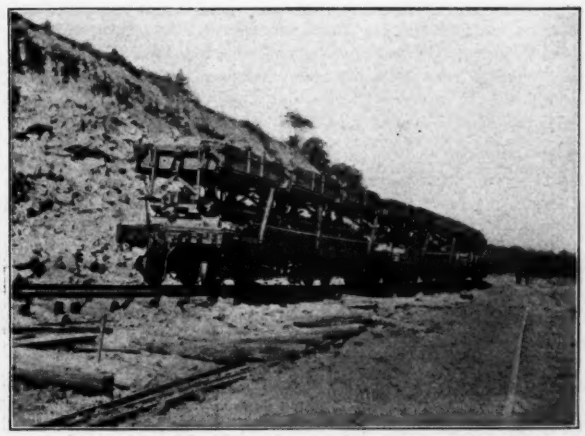
Ballasting work was resumed again about April 1, putting on the second lift. The track laying crew was reorganized in May. Track was then laid through Sangamon cut and fill, which had been completed, and no further serious delays were experienced in the track laying. First lift ballasting was carried very close behind the track machine, ballast trains occasionally being held until track could be full spiked by the track gang. White oak

ties were used, with the exception of 40,000 treated beech, maple and birch ties. Channel base plates were used at joints with ordinary angle bars. No tie plates were used.

Riprap.—An ingenious method was devised for handling the heavy riprap placed on the fill north of the Illinois River. The haul was a long one and the contractors found it advisable to use the railway standard gauge track. There were no standard gauge dump cars on the work, and the contractor's superintendent devised the scheme of mounting narrow gauge dump cars on flats. The photograph shows some of these cars. The dump cars were set off center far enough so that the stones cleared the edge of the flat cars, and were thoroughly anchored. To balance up the flats a number of rails were placed on the side opposite the dump car. This adaptation was the means of saving the contractor considerable money.

Comment.

The work was carefully organized and planned, and pushed with a vigor for which the Chicago & North Western Railway is known. The supervision was under engineers and other overseers of recognized ability, most of whom had been in the service of the railway for some years.



Narrow Gage Dump Cars Mounted on Standard Gage Flats, for Handling Rip-rap.

Consolidation locomotives with a tractive effort of 47,500 lbs. are being used on the new line, that is, from Benld to South Pekin. From South Pekin north to Nelson, the old Peoria division of the C. & N. W. Ry., Mikado locomotives with a tractive effort of 55,300 lbs. are being used. On this division the ruling grade is 1.0%, and this necessitates cutting down the train tonnage to about one-third, going north from South Pekin. In other words, one train from the new line will be broken up into three trains before starting over the old division.

Personnel.

The work was planned and executed under the supervision of William H. Finley, chief engineer of the Chicago & North Western Railway. The surveys and beginning of the construction work was under the immediate direction of W. C. Armstrong, resident engineer. Before construction was far advanced he was appointed bridge engineer and the field work was then placed in charge of D. Rounseville, resident engineer.

We are indebted to William H. Finley, assistant chief engineer, and to a number of the field engineers and other employes for data, plans and photographs from which this article was prepared. The general contract was executed by Winston Bros., Minneapolis. Cleary & White, Chicago, did the concrete work, and Roberts Bros., Chicago, did the track laying and ballasting.

WALLMAN MFG. CO. ESTABLISHES A CHICAGO BRANCH

For twenty-two years the Wallman Mfg. Co. of Milwaukee has manufactured a high grade line of oil storage systems applicable to every condition called for in railway shops, oil houses, factories and garages, keeping pace with every new development and maintaining a standard that has made their name a synonym for quality, not only in this country but internationally as well. Close attention to the details of the business and a practical knowledge of the art gleaned from a life's work devoted to it, has resulted in the production of the highest grade of product at the lowest cost of production, which enables this company to offer its products with the two most attractive arguments of superior quality and low cost. The determination of this company to let no competitive conditions cause a slighting of quality of the product enables it to offer an iron-clad guarantee of service and satisfaction under all conditions.

To further improve this service and adequately handle the railway business, the company has recently established an office in the Railway Supply Permanent Exhibit, Karpen building, Chicago, with W. C. Martin in charge, where an attractive display of this line of products is on exhibit.

NEW BOOKS.

GRAPHICS AND STRUCTURAL DESIGN—By H. D. Hess, M. E. Cloth, 6x9 in., 426 pages, 361 text figures. Published by John Wiley & Sons, New York. Price, $3.00 net.

A general treatise on structural engineering dealing with such problems as lie "on the border line between civil and mechanical engineering." Numerous more or less unsuccessful attempts have been made to put forth books of this nature for which there is a large field. Contrary to the general rule, this new book bears all the marks of a most successful volume on a most difficult subject.

The book is intended mainly for student use, but it will prove invaluable to the engineer engaged in general engineering work where a great variety of problems are to be met with. In fact it is a good book for the industrial or plant engineer, for it treats of the design of buildings and those accessories which are necessary to make up a complete plant, not including the special machinery for turning out the product.

The book opens with a chapter of general data on materials, common formulae and properties of steel sections. The next four chapters treat of graphical and analytical methods of stress analysis in structures, including the method of influence diagrams. Chapter 6 is devoted mainly to riveted connections and the theory underlying the common practice of riveting. The treatment of columns is short but well adapted to the purpose of the book. The design of conveyor girders, pipe line trusses, framed bents, and transmission towers is next treated, followed by a chapter on the design of a steel mill building. The treatment of transmission towers could have been made of greater value by giving space to methods of stress analysis which are omitted. The detailed design of a railway plate girder bridge although not strictly in keeping with the purpose of the book is given because it makes a better and more comprehensive problem than an ordinary crane or building girder design, illustrating as it does the use of moving loads in design. The detailed treatment of the design of structural members of jib and traveling cranes comprises two very valuable chapters. Chapter 14 on reinforced concrete is well written, giving a maximum amount of information in the small space available. The design of machinery and building foundations is a short but good chapter. Chapter 16 on chimneys is of special interest and value, treating as it does of the complete design of brick, self-sustaining steel and reinforced concrete chimneys in a most concise manner. The theory and design of retaining walls and bins are next discussed, the portion on bins being especially good. Shop floors, walls and roofs are treated in two short descriptive chapters. An excellent set of specifications covering materials, design and workmanship for both steel and reinforced concrete structures and also timber and masonry work in ordinary structures, are included in the book. In making up these specifications, the specifications of the A. R. E. A., Mr. C. C. Schneider and the American Bridge Co. have been freely drawn from, so there can be no doubt as to their authoritativeness.

Novel Type of Reinforced Concrete Abutment*

By Alfred W. Hoffmann.

General.

Bridge abutments transmit the load carried on the superstructure of the bridge to the soil, and they retain the earth or rock embankment, preventing the same from covering part of the superstructure. Broadly speaking, all bridge abutments belong to one of the following two classes:

1. Abutments designed to resist the pressure exerted by the embankment.

2. Abutments designed to eliminate or balance this pressure.

Most plain concrete gravity abutments and reinforced concrete U-abutments belong to the first class. A large variety of types belonging to the second class has been developed during the last few years, and these more modern types have been made possible by the marvelous advance made recently in designing and construction methods for reinforced concrete. It can be justly claimed that this second class of abutment types, although of very recent date, is destined to grow to far greater importance than the first class, on account of its adaptability to even the most unfavorable local conditions. In many cases where abutments resisting earth pressure cannot be used except at a great expense, the modern types lend themselves readily to overcome local difficulties, such as excessive height, poor soil, restricted clearances, and various other problems.

Lind Viaduct near Lind, Wash., Puget Sound Line, C., M. & St. P. Ry. (Fig. 15).

The problem of keeping the bearing on the soil below a certain maximum is very often of the greatest importance. In an abutment resisting the earth pressure the bearing on soil is variable, the maximum intensity occurring at the front edge of the footing. This maximum governs the design of the foundations, and it is evident that the relatively small bearing on the soil near the back of the abutment represents an economic waste. If the earth pressure is eliminated, or balanced by proper selection of the type of abutment to be used, the bearing on the soil is more nearly uniform, and practically every square foot of the base is almost fully utilized. Settlement, if such occurs, is also more nearly uniform, than that of a structure which exerts a pressure much greater on some parts of the subsoil than others. The danger of sliding, resulting from the unbalanced earth pressure, is also, to a large extent, eliminated by the use of a type which is based on balancing the earth pressure.

Of the many types of this class, the trestle and rigid frame abutments offer probably greater advantages than any of the other types. Leaving all other considerations, such as waterway clearances, etc., aside, a plain concrete front wall, or a reinforced concrete bent, provided with a bridge seat, and retaining wall back of the end of the superstructure, as shown in Fig. 1, is the cheapest possible type of an abutment. If, however, the height increases, such an abutment lacks stability. It also reduces the horizontal clearance between the abutments. This may not be permissible for a bridge crossing a waterway. Stability can be gained by adding one or more bents connected with the first bent or bridge seat, thus lengthening the abutment, and also increasing the horizontal clearance. This is illustrated in Fig. 2, which shows the simplest form of a trestle or frame abutment. Additions to the width of the clearance for the waterway, provision for roads, streets, railroad crossings can be economically and easily made by adding to the length of the abutment and by a proper arrangement of the openings through the abutment side walls. A deck is required to carry the ballasted track.

Wherever a permanent structure is to replace a temporary wooden trestle, a reinforced concrete or frame abutment will be found to cause less interference and changes to the wooden trestle than a gravity U-abutment. The legs or posts and cross beams can always be arranged so as to clear the trestle bents and the floor system.

The thickness and reinforcement of walls resisting earth pressure increases rapidly with increasing height. The economical limit for high gravity or U-abutment is, therefore, soon reached, while the increased height of a concrete trestle or frame abutment requires very little increase in the concrete sections, and a few additional struts. The most expensive part of a trestle or frame abutment is the deck, the floor beams and side girders or arches, and these are absolutely the same for certain spans, no matter how great the variations in height are. It is evident, therefore, that this type of abutment can be used to great advantage for high structures, and that it cannot compete with the gravity and the U-abutment for small heights, except in special cases where additional water way or clearances for other purposes must be provided for, without increasing the length of the superstructure.

Trestle Abutments. The reinforced concrete trestle abutment is not essentially different from the well-known types of trestle viaducts except that a bridge seat for the support of the superstructure must be provided for. The bents may be solid concrete walls, or columns, properly braced, for great heights. An interesting example of this type is shown in Figs. 3 and 6, which is the design for the west abutment for the Chatcolet Viaduct, on the Puget Sound line of the Chicago, Milwaukee & St. Paul Ry. The original gravity abutment was so located that the fill, if extended to the back of the abutment, would partially cover the first steel bent. This structure was designed to replace a temporary timber trestle which carried the track between the gravity abutment and the end of the embankment, the slope of which is shown in the illustration Fig. 3. The light longitudinal struts were provided merely to hold the concrete trestle bents in position until the slabs were placed. The span of the slabs is 19 feet. The concrete bents are battered in order to get lateral stiffness and a large footing area, as this structure was to be set on a rock fill only a few years old which was not

* Copyright, 1914, W. E. Magraw.

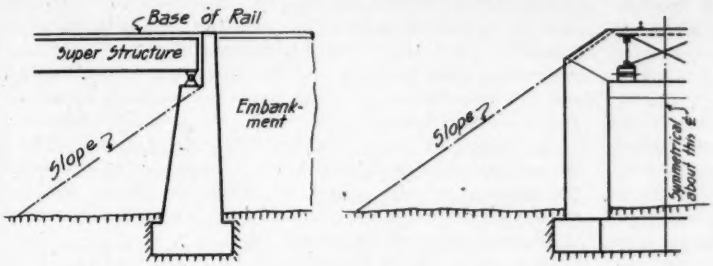


Figure 1.

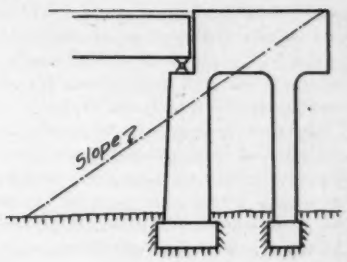


Figure 2.

supposed to carry a heavy load per square foot. This structure was designed for Cooper's E-55 loading. Falsework and reinforcement details are shown in the illustration, Fig. 3.

Frame Abutment. Of far greater importance is the reinforced concrete frame abutment. The floor system consists of a concrete slab which may be built in place or separate and erected later. The slab is supported on floor beams perpendicular to the center line of track, framing into side girders or arches, supported by legs or posts. The legs and floor beams form rigid frames resisting lateral forces, such as wind, and centrifugal force, on curved structures only. The legs and side girders form rigid frames to resist the tractive forces.

An exact analysis of the stresses in a structure of this kind is necessarily very complicated, and will not be attempted here. It will, however, be seen that simple and sufficiently correct and safe methods can be devised for computing the stresses and proportioning the various members.

It will be preferable to build the reinforced concrete slab in place, where no interference with falsework prevents such procedure. If built in place, it is to be recommended to build the slabs continuous. Provision must then be made for negative moments over the cross beams. The positive moments at the centers of the spans would be correspondingly reduced. Such a reduction cannot be recommended, however, because cracks might develop in top of the slab over the cross beams, on account of unequal settlement, and then the moment at the center would be more nearly equal to the moment for a simple beam than to the moment for a continuous beam. If the slab is proportioned to take the moment for a simple beam at the center then any cracks over the supports will not, in ordinary cases, reduce the safety of the structure.

The cross beams can be figured as T-beams if the slab is built in place. They are framed rigidly into the side girders, negative moments therefore occur at the ends where the width of the compression zone equals the width of the stem only. If the cross beams are figured as T-beams, the depth at the end should be increased by a bracket in order to keep the compressive fibre stress below the allowable limit.

In most cases, these structures must be built without interruption to traffic over a trestle which would interfere with building the floor system of the new structure in place. The deck slabs must then be built separate and later placed on the cross beams which are built in place in all cases. The slabs must be provided with handling rods or other means to facilitate erection. The weight limit depends on the available equipment for erection. The slabs must be designed as simple beams; a certain number of the bars in bottom of the slab should, however, be bent up, the bends to be staggered. Some of the bent up bars can be used then, to take all or part of the shear, and others to take such negative moments as may occur over or near the floor

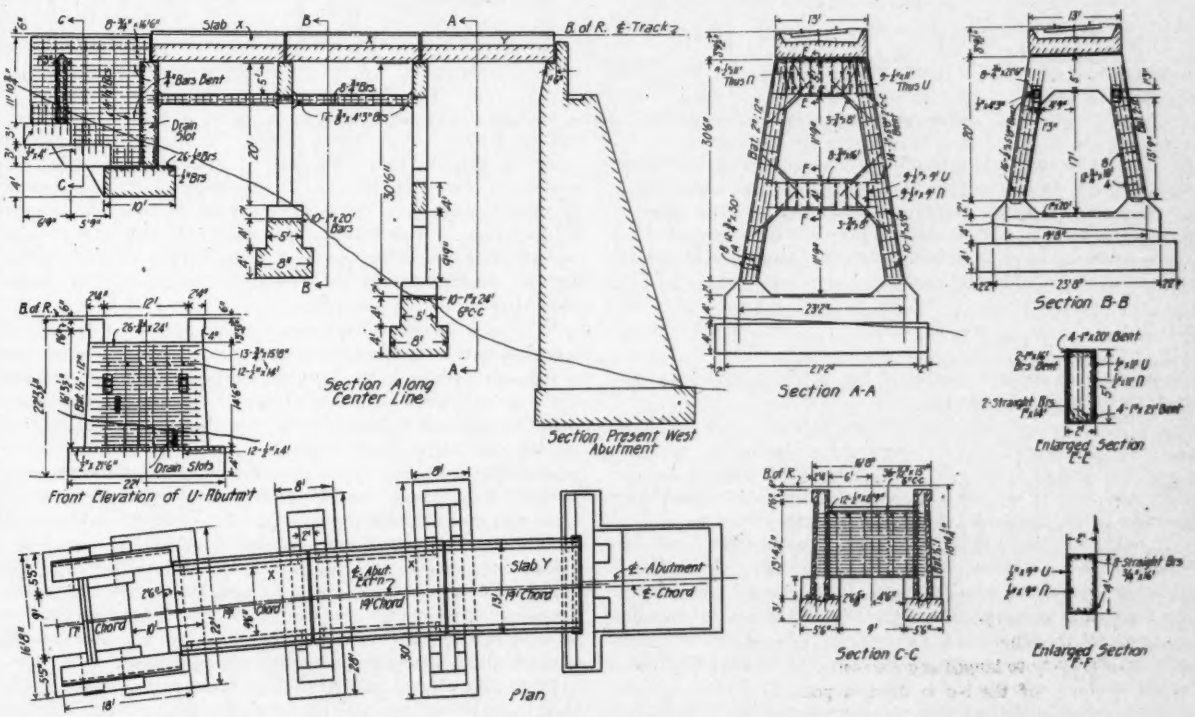


Fig. 3a. Details of West Abutment Extension, Chatcolet Viaduct, P uget Sound Line, C., M. & St. P. Ry.

beams, under certain conditions of loading. Stirrups must be used to take that portion of the shear which cannot be carried by the bent bars. It is also advisable to make liberal provision for transverse bars to distribute the load over the full width of the slab, as nearly uniform as can be obtained.

The floor beams or cross beams are designed primarily to transmit the load, received from the slabs, to the side girders. Secondarily, they must resist the shears and moments produced by the lateral forces such as wind pressure and centrifugal force. For these secondary stresses, the cross beam must be considered the top member of a rigid frame with two legs if the structure is for single track, and possibly with three legs if the structure is for double track.

A rigid frame of this kind is a statically indeterminate structure the analysis of which can be found in many handbooks. Any horizontal or vertical force acting on the frame produces a reaction on the base of each leg which is unknown in size as well as in direction. There are altogether four unknown quantities, occurs between the base and the top. The location of the point of contraflexure depends on the moments of inertia and the lengths of the different members, and the rigidity of the base connection. Practical rules and approximations for locating the point of contraflexure are given in the text-books on mechanics. The moment at the top of the leg is the product of the horizontal component of the reaction times the distance between the top and the point of contraflexure. A straight line connecting the maximum moment plotted as ordinate at the top with the point of contraflexure and produced till it intersects the ordinate at the base represents the moment curve.

All reactions, shears and moments are linear functions of the horizontal force applied. It is, therefore, advisable to determine all reactions, shears and moments for a force 1 and to multiply the stresses found with the actual forces applied, which may be wind alone or wind and centrifugal force combined. Wind on the leg itself causes bending in same, but can be neglected in most cases.

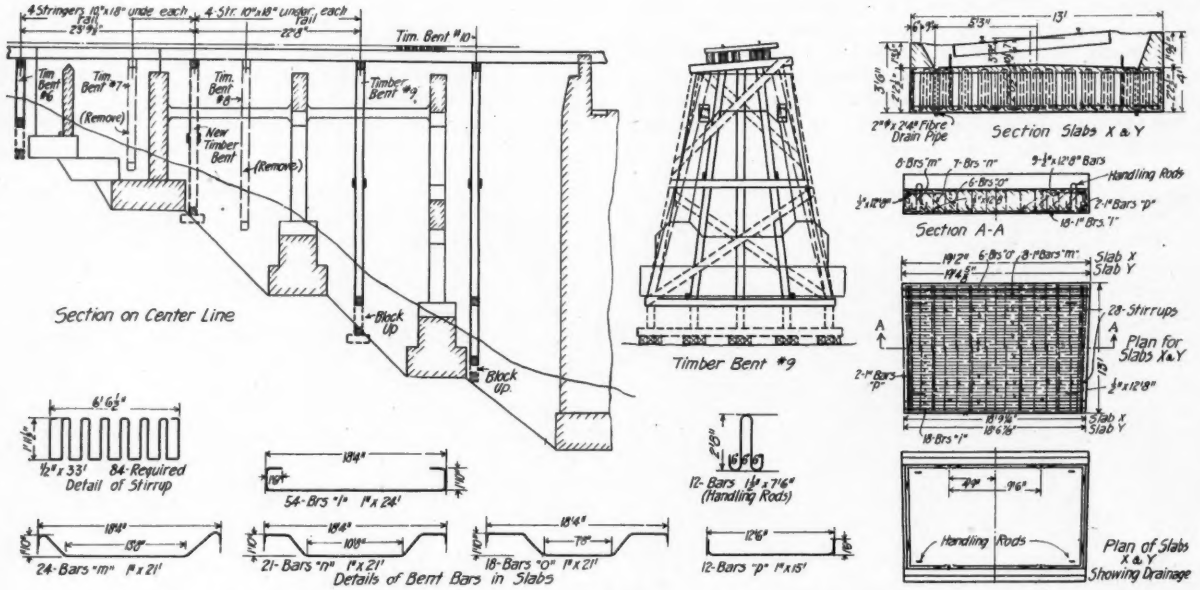

Section on Center Line
Timber Bent #9
Section Slabs X & Y
Section A-A
Plan for Slabs X & Y
Plan of Slabs X & Y Showing Drainage
Details of Bent Bars in Slabs

Fig. 3b. Details of West Abutment Extension, Chatcolet Viaduct, Puget Sound Line, C., M. & St. P. Ry.

two horizontal and two vertical components, while the conditions of equilibrium furnish only three equations. The simplest solution of the problem is by the method of least work. In most cases the length and moment of inertia is the same for both legs, and then the reaction can be easily found. For a horizontal load H applied at the top of the horizontal reaction at each leg

$$R_h = \frac{H}{2}$$

If the distance center to center of legs is l, and the height is h, then the vertical reactions are

$$V = \frac{H \times h}{l},$$

since the moment of the vertical forces must be equal to the moment of the horizontal forces, but of opposite sign.

A horizontal load applied at the top produces shears and moments in the top member or cross beam. The shear on each leg is constant from top to base and equals the horizontal component of the reaction at each leg. The moment is zero at the bottom and a maximum at the top equal to the product of horizontal component of reaction times the length of the leg. The moment diagram is represented by a triangle.

These values apply to hinged end connection at the bottom only. If the bottom end of the leg is fixed, a point of contraflexure

It may be mentioned here that, in applying the method of least work, the work done in the deformation of the members by direct stresses and by shearing stresses can be and always are neglected, because these stresses contribute only a very small percentage to the work performed. The work performed by the bending stresses alone is considered, and the formulas are materially simplied by this assumption.

Fig. 4 is a diagram of the shears and moments due to vertical and horizontal loads for a frame with two legs of equal length and moment of inertia. This diagram is typical for intermediate and rear end bents. The lateral stresses are, and should be assumed in all cases to be carried by one cross beam framing into the legs. If intermediate cross beams are used, they should be detailed the same way as the cross beams framing into the legs.

Generally speaking, the legs or posts have a smaller moment of inertia than the cross beams, and offer but little resistance to bending in the cross beams. Therefore, the cross beams are almost simple beams, the positive moment at the center being but slightly reduced by the negative moment at the end. Of course, provision must always be made for the maximum negative moment at the end of the cross beam; the positive moment should, however, always be computed as for a simple beam.

Fig. 5 is a diagram similar to Fig. 4, but for concentrated vertical loads. This diagram is typical for the case of the bridge seat if the same is detailed as a rigid frame. The above comments

apply to this case also. In some cases it will be found more economical to use a solid concrete wall as a bridge seat; in others a bent will be much more economical, in which case the theoretical basis for the computations is the same as for the intermediate or end bent. The details, however, are essentially different from the intermediate bents, as is shown in the illustrations.

The side girders and posts are members of a longitudinal system of rigid frames. If the abutment is very short and has only one span of side girders, then the method of computing stresses is the same as for the tranverse bents, tractive forces being substituted for wind and centrifugal forces. In most cases, however, the number of spans is two or more, and while the number of equations derived from the conditions for equilibrium remains always the same, two more unknown reactions are added with each additional post. The computations for shears and moments in the side girders themselves become more complicated as

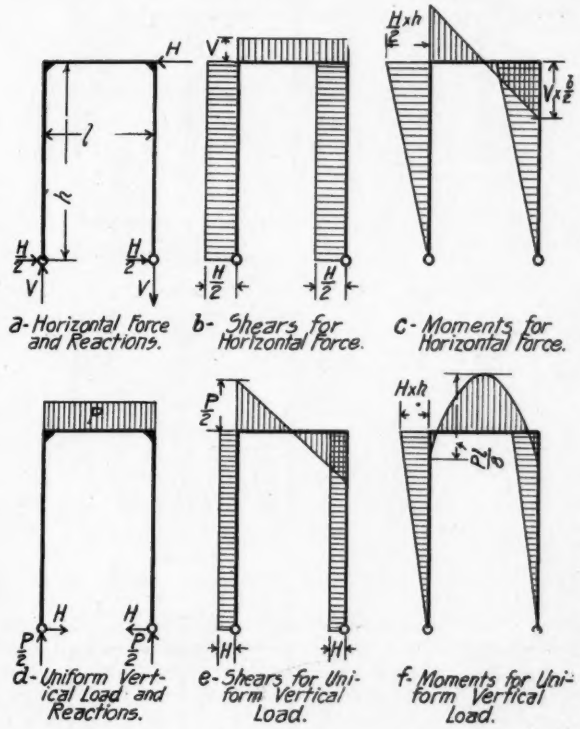

a- Horizontal Force and Reactions.
b- Shears for Horizontal Force.
c- Moments for Horizontal force.
d- Uniform Vertical Load and Reactions.
e- Shears for Uniform Vertical Load.
f- Moments for Uniform Vertical Load.

Figure 4.

the number of spans increases. Approximate methods should be used to determine the reactions and stresses with a reasonable degree of correctness.

The three-moment theorem can be used to compute the moments and shears caused by vertical loads in the continuous side girders in cases where the nature of the foundation is such that settlement is not likely to occur. In all other cases it is decidedly more conservative to design the side girders for a positive moment equal to that for a simple beam, based on the clear span of the side girders. If the continuity is totally or partially destroyed by unequal settlement, then the safety of the structure will still be the same. It would seem to be a considerable waste of effort to determine the exact moments and shears in the side girders, in view of the fact that the conditions affecting the moments and shears change considerably in case of unequal settlement, and also in view of the fact that the side girders are framed into the posts instead of resting on knife-edge supports such as are assumed for the three-moment equations. It would be of far greater importance to investigate the moments and shears in a continuous girder framed into elastic posts. This problem cannot be discussed here for lack of space. It should, however, be kept in mind that too high a degree of refinement in the computations of the stresses in the continuous side girders is not necessary, unless the local conditions give reasonable assurance that the structure under load will act about the way it was assumed to act.

Conservative design is the most vital requisite for success in reinforced concrete construction; it is, however, more essential for railroad work than for any other kind of work. The main consideration in all questions pertaining to the design of a railroad bridge is safety without waste. We find that designing the side girders of framed concrete abutments for positive moments equal to those in a simple beam with clear span between columns is safe, and calls for very little more reinforcement than would be required for the actual positive moment in a continuous beam based on the spans center to center of columns. The same amount of reinforcement should be used over the supports as at the center. Shearing stresses should be carried by bent bars and stirrups.

Considering the side girders as members of rigid frames stressed by horizontal tractive forces, there are both shears and moments produced in the side girders by these forces. The stresses in the legs can be found after the reactions at the base of each leg are found. This problem is also solved by the method of least work, the work done in the deformation of each member is integrated,

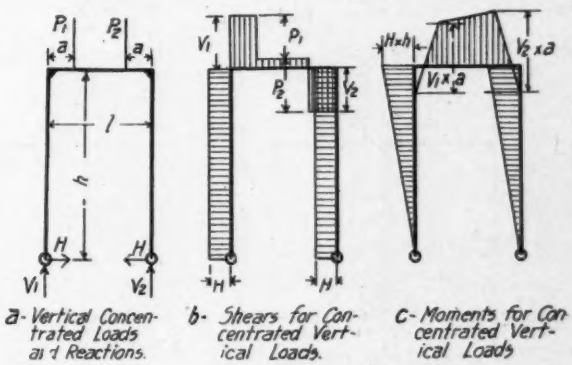

a- Vertical Concentrated Loads and Reactions.
b- Shears for Concentrated Vertical Loads.
c- Moments for Concentrated Vertical Loads

Figure 5.

and then differentiated with respect to the unknown reactions, which gives a number of equations for the unknown quantities sufficient for their determination.

In a similar way the influence of a vertical load on all members can be found, all shears and moments found must then be combined into maximum and minimum shears and momeuts for each member which is to be proportioned for the maximum conditions. The posts carry a direct load, and are stressed by moments in two planes, one perpendicular to the center line of the structure, the other parallel to the same. Uplift and downward pressure due to wind and traction must be considered in figuring the direct load. The absolute maximum of stress occurs at one corner. It is equal to the direct stress plus the extreme fibre stress due to wind and centrifugal force (where the latter applies) plus the extreme fibre stress due to traction. It is reasonable to allow a higher value for this absolute maximum, because such a combination of stresses is not likely to occur frequently, and also because the stress is a maximum at the corner only and considerably reduced a short distance either way from the corner. Yet it is advisable to compute this maximum and to take it into consideration in proportioning the posts, always making proper allowance for the conditions.

Where the ends of the posts are fixed, or struts are used, the methods of calculation are similar. All conditions that might have an influence on the position of the points of contraflexure must be carefully weighed, and moment curves drawn to pass through points of contraflexure.

Fig. 6 is a diagram of shears and moments in a three-legged frame as it is most frequently used for abutments of this type.

A somewhat simpler way to find the reactions due to a horizontal load applied to a three-legged frame is to find the deflection of each leg as a function of its length, moment of inertia and the reaction applied. The deflections of all posts must be equal, since the legs are rigidly tied together at the top by the side girders. This condition and the fact that the sum of the reactions must equal the applied force are sufficient for the determination of the horizontal reactions. These reactions known, it is then possible to find the vertical reactions by passing sections through the structure so as to get equations for moments with one unknown quantity only. Proportioning the members is done the same way as discussed before.

After the loads and moments on the columns are determined, the design of the foundations offers no difficulties and requires no detailed discussion.

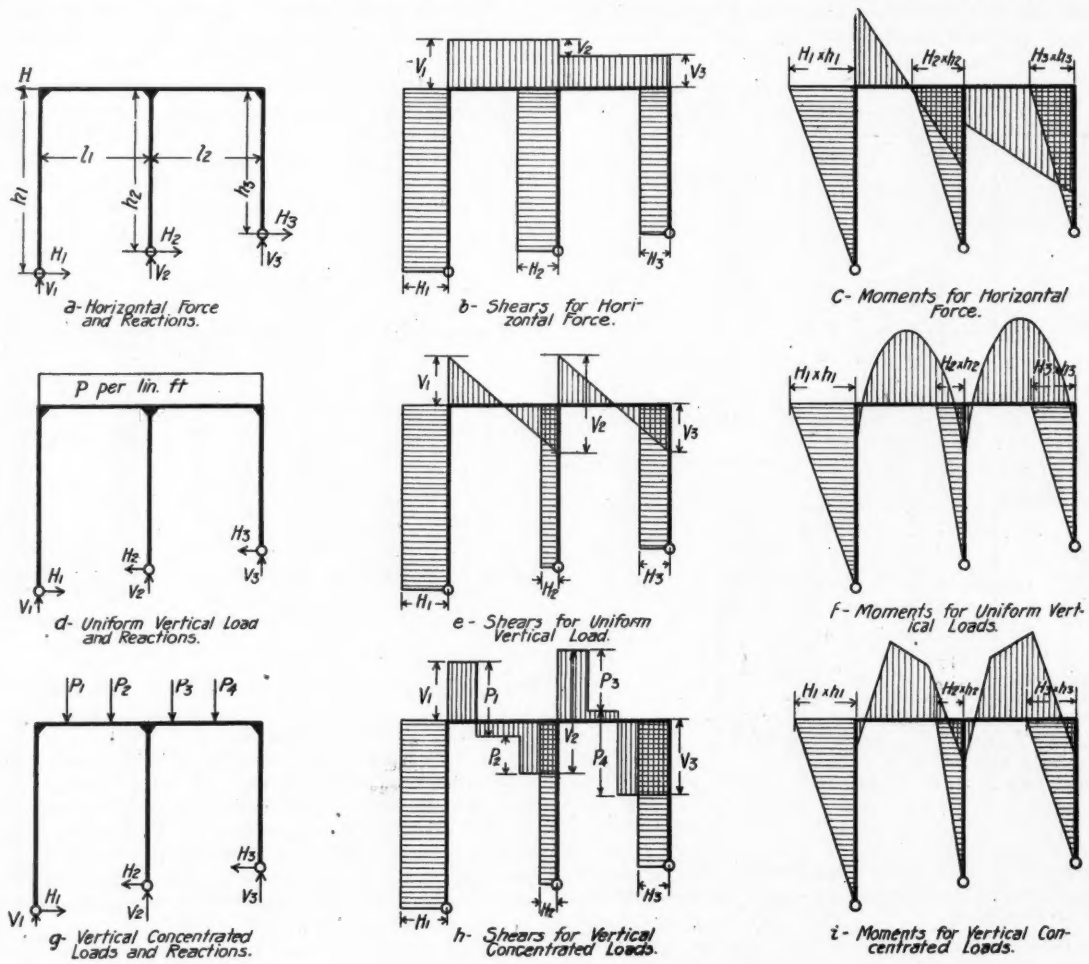

a- Horizontal Force and Reactions.
b- Shears for Horizontal Force.
C- Moments for Horizontal Force.
d- Uniform Vertical Load and Reactions.
P per lin. ft
e- Shears for Uniform Vertical Load.
f- Moments for Uniform Vertical Loads.
g- Vertical Concentrated Loads and Reactions.
h- Shears for Vertical Concentrated Loads.
i- Moments for Vertical Concentrated Loads.

Figure 6.

Practical Considerations. An important consideration influencing the design of the concrete frame abutment is the spacing and the depth of the cross beams. The top of the side girders must be at or near the elevation of base of rail, as they must retain the ballast. Assuming 8-inch ties and a minimum thickness of the layer of ballast under the ties of 8 inches, the top of the concrete deck slabs is 1 foot 4 inches below the base of rail. The thickness of the slabs is generally about 1 foot, and therefore the top of the cross beams is about 2 feet 4 inches below the base of rail. The spacing of the cross beams is restricted by the limitations to the size and weight of the slabs in case the slabs are built separate and erected afterwards. The spacing of the cross beams should not exceed 10 feet, and should ordinarily be about 8 feet. Assuming the clear span of the cross beams between the side wall girders to be about 14 feet, a minimum depth of 4 feet 6 inches to 5 feet is required for the cross beams. Thus the bottom of the cross beams will be about 7 feet below the base of rail. For proper framing of the cross beam reinforcement into the side girders without interference to the main reinforcement in the bottom of the side girders, the bottom of the cross beams should be raised at least 6 inches above the bottom of the side girders. These practical considerations suggest a minimum depth of 7 feet 6 inches for the side girders. This depth is excessive and not economical for short side girder spans. The economical length of side girder spans of this depth is between 15 feet and 25 feet. The layout of the abutment should, therefore, be made for spans approaching these lengths, which are also more economical concerning the design of posts. The section of the posts must necessarily be large to carry the relatively heavy bending stresses in two planes, these stresses depending not so much on the span of the side girders as on the length of the bridge span which governs, moving wind load and tractive forces.

The minimum section of the posts is, of course, determined by the direct load on the posts, to which must be added the downward pressure due to wind and traction. The increase in the section of the posts required on account of moments produced by the horizontal reactions can be kept as low as desired by the use of horizontal struts spaced close enough. One point of contraflexure is located in each section of the post between two struts; the point of contraflexure is generally near the center of the space between the struts if the moment of inertia of the post is con-

stant. It is evident that too close spacing of the horizontal struts would be more expensive than a reasonable addition to the column sections. A study of the local conditions and the appearance of the abutment will reveal the best and most economical arrangement.

From the foregoing discussion it is plain that, except for some variations in the spacing of cross beams and in the span lengths of the side girders, the design of the floor system and side girders is almost always the same and lends itself readily to standardization. It can be said that the cost of the floor system and side girders is a linear function of the length of the abutment for a certain span of the side girders. Simple rules can be worked out for the posts, and then the only variables requiring special study are the bridge seat, or front of the abutment, and the foundation.

The bridge seat design can be worked out for such spans of the superstructure as are likely to occur most frequently, and then the variations can easily be found for longer or shorter spans in special cases. Provision for horizontal forces can be made by adding strength to the posts or by arranging struts with a view to keeping the bending moments acting on the posts as low as convenient.

The foundation design cannot very well be standardized, and must be worked out in each case. For estimating this type of abutments it should be kept in mind, however, that the most expensive part of the structure is its upper part, and that the cost of the foundation does not play such an important part in the total estimate as is the case with gravity or U-shaped abutments. The larger share of the total cost of the latter types is for the cost of the underground work. Therefore, it can be claimed that the concrete trestle and frame abutment can be estimated closer to the actual cost than the gravity or U abutment.

It is well to mention here another advantage of these modern types of abutments. They permit the more extensive use of standard steel superstructures, allowing, as they do, a certain amount of adjustment of horizontal clearances to suit any particular case. It is often possible to avoid a longer steel span for a road clearance or similar requirements by supporting the standard length steel span on a concrete trestle or frame abutment which can be designed to give the desired clearances between the posts. It is not extravagant to say that this type of abutment can be highly standardized and permits a higher degree of standardization of the superstructures. It will ultimately lead to the adoption of a number of standard crossings, which can be laid out in such a manner as to take care of local clearance and other requirements by varying the number of standard spans and by a proper abutment design.

Examples and Economy. These possibilities are well illustrated by some of the crossings of the Puget Sound line of the Chicago, Milwaukee & St. Paul Ry. over the Pine Creek near Malden, Wash. The second and third crossings of Pine Creek were laid out for two and three steel spans, respectively, the ends of the superstructure being supported on abutments of the type just described. The reason for the adoption of this type was, in both cases, the necessity of increasing the width of the waterway which would have been available between the ends of the steel structure if the latter was carried on gravity abutments. The abutments for both these bridges are almost identical, except for the fact that the substructures for the second crossing of Pine Creek are carried on piles, while the foundations for the third crossing of Pine Creek rest on rock or gravel. Fig. 7, a, b, c, and d, shows a number of details of the abutments for the second crossing of Pine Creek.

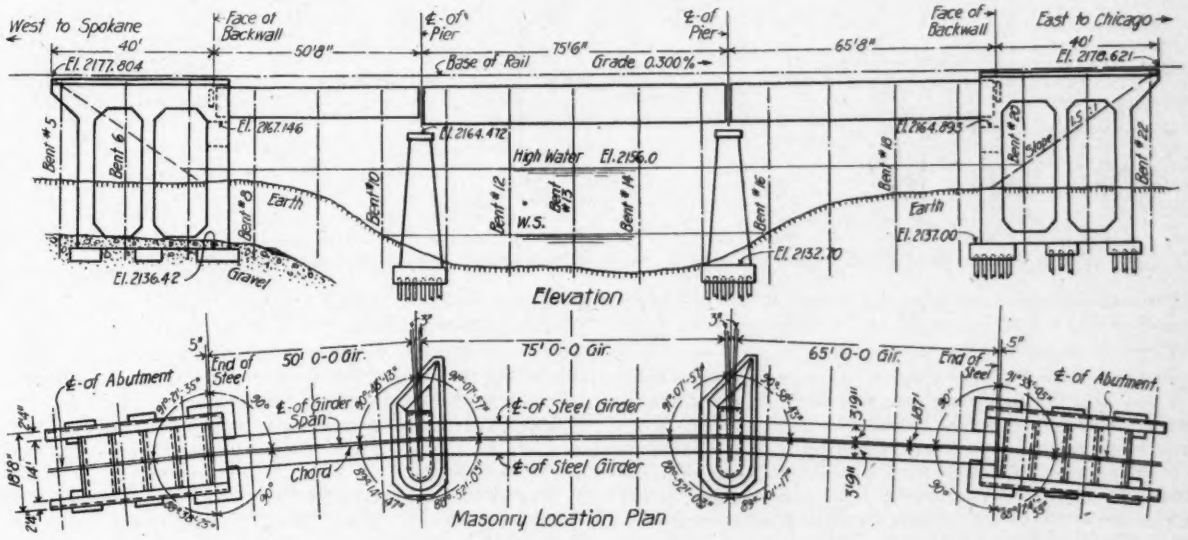


Fig. 7a. General Plan and Profile of Second Crossing of Pine Creek, Puget Sound Line, C., M. & St. P. Ry., near Malden, Wash.

It has been mentioned before that there is very little variation in the depth of the side girders. If a certain concrete section is assumed, the steel reinforcement can be plotted as a function of the span. This applies to both the main reinforcement and the web reinforcement. The shear and moment diagrams, Fig. 8, have been prepared for the computation of the main and web reinforcement for the side girders for spans varying from 15 feet to 35 feet. The curves for the weight of the reinforcement are shown in Fig. 9. These diagrams are based on Cooper's E-50 live load, 50% impact, a tensile stress on the steel of 13,500 pounds per square inch, and a compressive fibre stress on the concrete of 750 pounds per square inch. Fig. 9 also shows curves for the quantities of concrete in the side girders per lineal foot of abutment; also the quantities for slabs and cross beams per lineal foot of abutment. The details of the reinforcement are shown in the illustrations.

The top member of the bridge seat frame is practically independent of the length and height of the abutment, and can be made identically the same for a certain length of steel girder span. For very long and heavy spans it is advisable either to design a solid front wall as bridge seat or to design the posts so that they carry the load directly. Then the top of the frame acts merely as a strut and can be made very light.

It would be very simple to plot curves for the design of the bridge seat for various superimposed loads and spans. Such curves would be of additional help for estimating and designing the bridge seat or front wall.

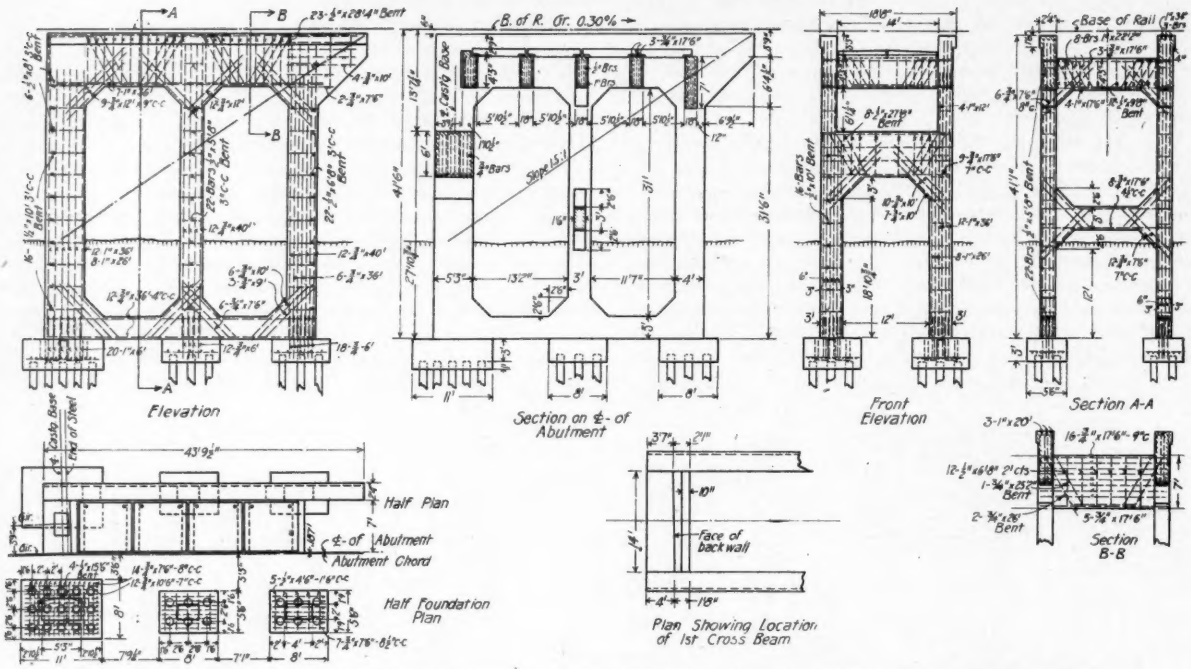


Fig. 7b. Details of East Abutment, Second Crossing of Pine Creek, Puget Sound Lines, C., M. & St. P. Ry.

The various factors governing the design of the posts have been discussed before, and curves can be conveniently drawn for their design and estimate.

Before the new type was adopted for the abutments shown in Fig. 7., comparative estimates were made for a gravity abutment, a U-abutment and for the rigid frame abutment. All figures were based on the cost of construction only, and no allowance was made for the advantage of an increased waterway clearance. The three types of structures were estimated regardless of any advantages or disadvantages other than the difference in the cost of construction. The west abutment, adopted type, was estimated to cost:

Excavation, 350 cu. yds. @ $2.00	$ 700
Concrete, 223 cu. yds. @ $15.00	3,345
Reinforcing steel, 32,000 lbs. @ 35c	1,120
Fill (between columns), 520 c. yds. @ 25c	130
Engineering, about 10%	530
Total first cost	$5,825

The cost of a U-abutment was estimated to be as follows:

Excavation, 500 cu. yds. at $2.00	$1,000
Changes to falsework, lump	200
Concrete in footings, 58 cu. yds. @ $7.50	435
Concrete in neatwork, 490 cu. yds. @ $12.00	5,880
Reinforcing steel, 27,000 lbs. @ 3c	810
Fill (between sidewalls), 700 cu. yds. @ 25c	175
Engineering, about 10%	850
Total first cost	$9,350

The cost of a gravity abutment, for which a much higher toe pressure on the soil was allowed, was estimated to be the following:

Excavation, 1,500 cu. yds. @ $1.50	$ 2,250
Plain concrete, 1,165 cu. yds. @ $8.00	9,320
Changes to falsework, lump	100
Fill, 750 cu. yds. @ 25c	190
Engineering, about 10%	1,190
Total first cost	$13,050

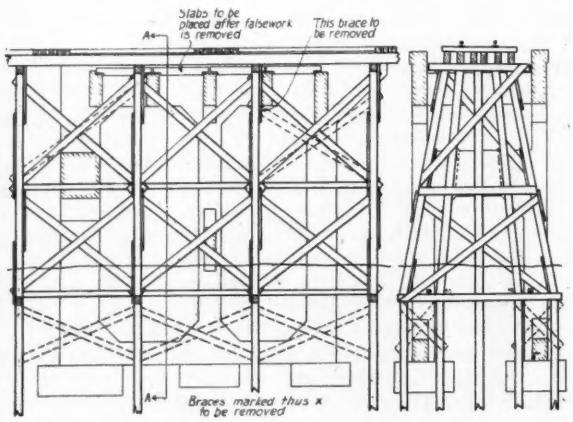


Fig. 7c. Falsework Details, Second Crossing of Pine Creek.

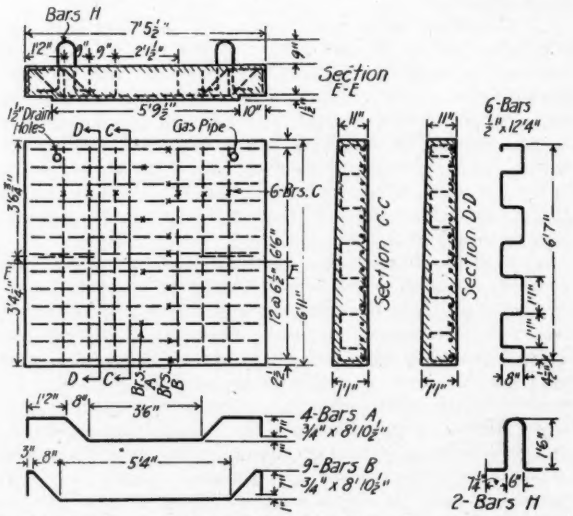


Fig. 7d. Details of Reinforced Concrete Slabs, Second Crossing of Pine Creek.

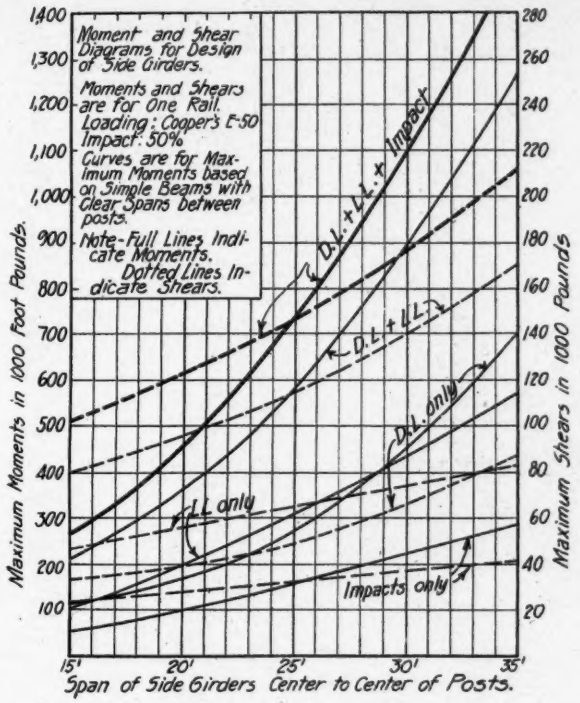

Moment and Shear Diagrams for Design of Side Girders.
Moments and Shears are for One Rail. Loading: Cooper's E-50 Impact: 50%
Curves are for Maximum Moments based on Simple Beams with Clear Spans between posts.
Note-Full Lines Indicate Moments. Dotted Lines Indicate Shears.
D.L.+L.L.+Impact
D.L.+L.L.
D.L. only
L.L. only
Impacts only
Maximum Moments in 1000 Foot Pounds.
Maximum Shears in 1000 Pounds
Span of Side Girders Center to Center of Posts.

Figure 8.

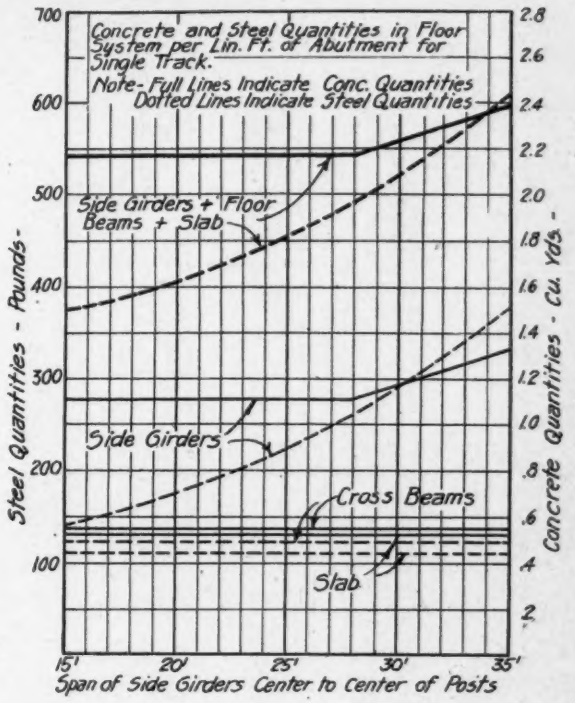

Concrete and Steel Quantities in Floor System per Lin. Ft. of Abutment for Single Track.
Note-Full Lines Indicate Conc. Quantities Dotted Lines Indicate Steel Quantities
Side Girders + Floor Beams + Slab
Side Girders
Cross Beams
Slab
Steel Quantities - Pounds
Concrete Quantities - Cu. Yds.
Span of Side Girders Center to Center of Posts

Figure 9.

The comparative cost of various types of abutments for this structure illustrates very forcefully the economy of this modern type over the older gravity and reinforced U-abutments.

In the last few years a large number of abutments of this type have been built, and many examples could be given of large and interesting structures. For the purpose of this article it is considered sufficient to show, in Figs. 10, 11, 12 and 13, the details for one more structure, the Spokane River bridge on the Coeur d'Alene line of the Chicago, Milwaukee & St. Paul Ry. All structures described in this article were designed in the engineering department of the C., M. & St. P. Ry., Mr. C. F. Loweth, chief engineer, Mr. J. H. Prior, engineer of design.

The bridge shown in Figs. 10, 11, 12 and 13, crosses the Spokane River at an angle of 60°. It was, therefore, found advisable to place the first two bents next to the front wall in the long abutment at a skew with the center line of the bridge, this angle becoming 90° for the third, fourth, fifth and sixth bents. A road 14 feet wide passes through the fourth opening, above the high water level. The slope of the embankment must clear the width of the roadway, and the length of the abutment is thereby fixed.

The skew bents are braced by struts independent of the floor beam system. The floor beams are placed at right angles with the center line of the bridge to simplify the design of the concrete slabs. Special skew slabs are required immediately back of the plain concrete front walls.

The short abutment is also designed to provide clearance for a roadway, which is, however, nearer the front wall.

An interesting feature of this bridge is the provision for double track extension. The three piers in the river bed and the front walls of both abutments are built for double track, while the rest of the structure is built for single track. The foundations, however, were built for future double track, as is shown in the details. Fig. 14 is a view of the complete structure, which illustrates very effectively the architectural possibilities of this type of abutments, although the layout of this structure was by no means favorable to an esthetic treatment, on account of the skew and the irregular and unsymmetrical spacing of the posts.

Among the highest structures of this kind ever built are the abutments for Lind Viaduct, on the C., M. & St. P. Ry., near Lind, Wash. These abutments are shown in Figs. 15, 16 and 17. A simple yet effective scheme of paneling has been used for the

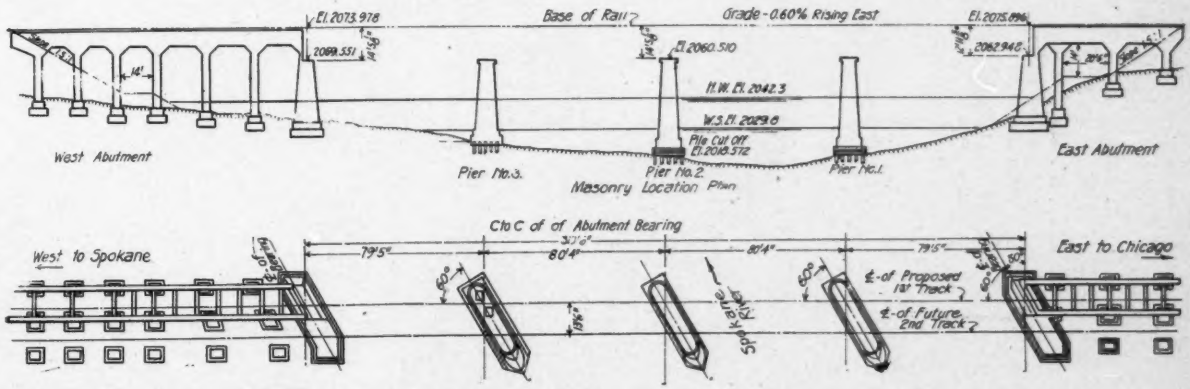


Fig. 10. General Plan and Profile of Spokane River Bridge, Coeur d' Alene Line, C., M. & St. P. Ry.

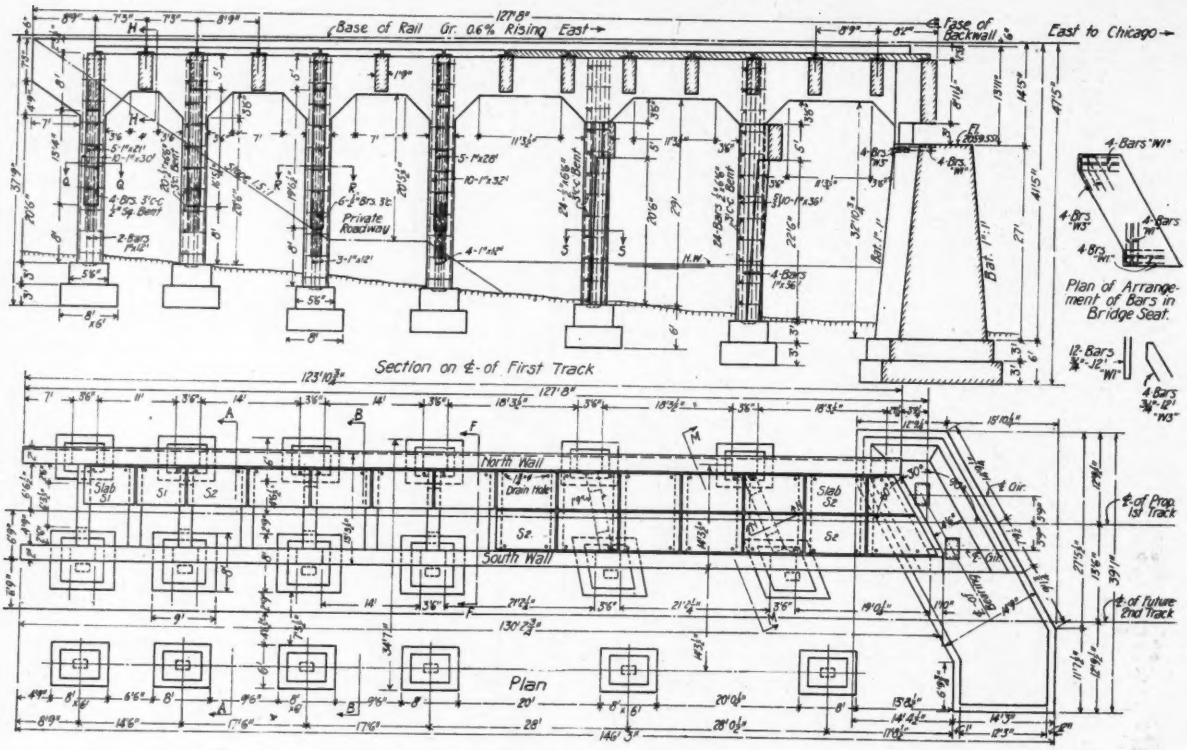


Fig. 11a. Plan and Longitudinal Section of West Abutment, Spokane River Bridge.

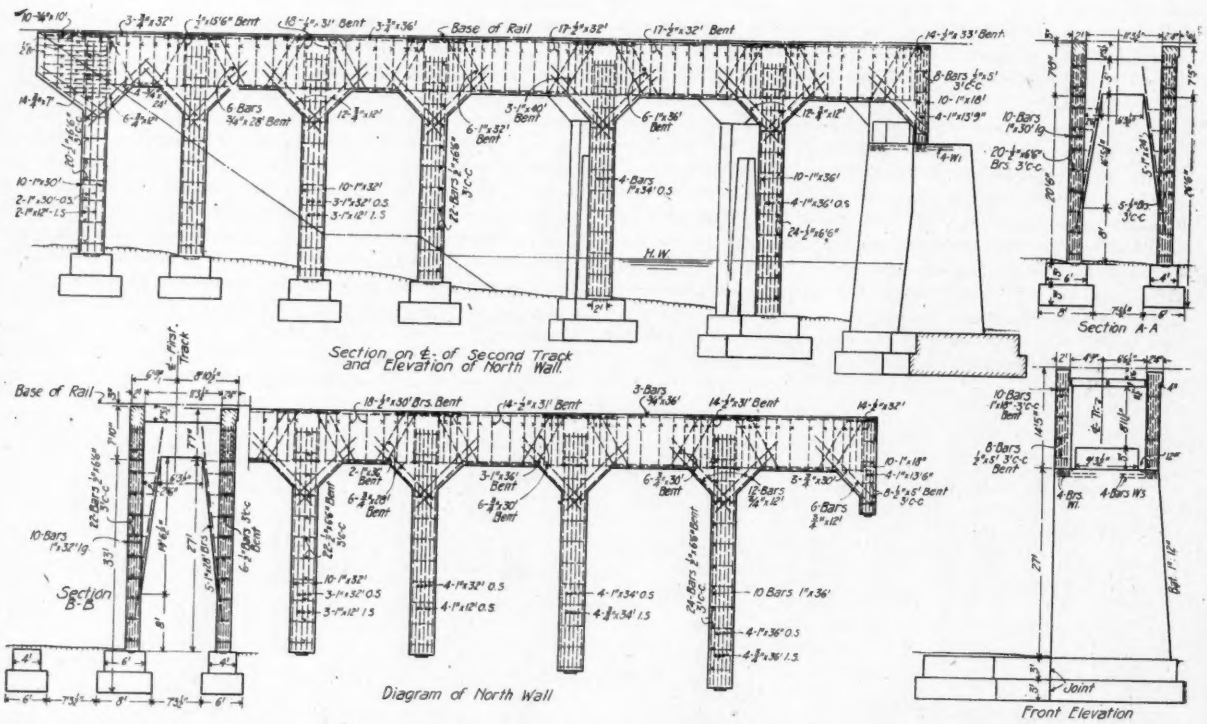


Fig. 11b. Sections and Elevations of West Abutment, Spokane River Bridge.

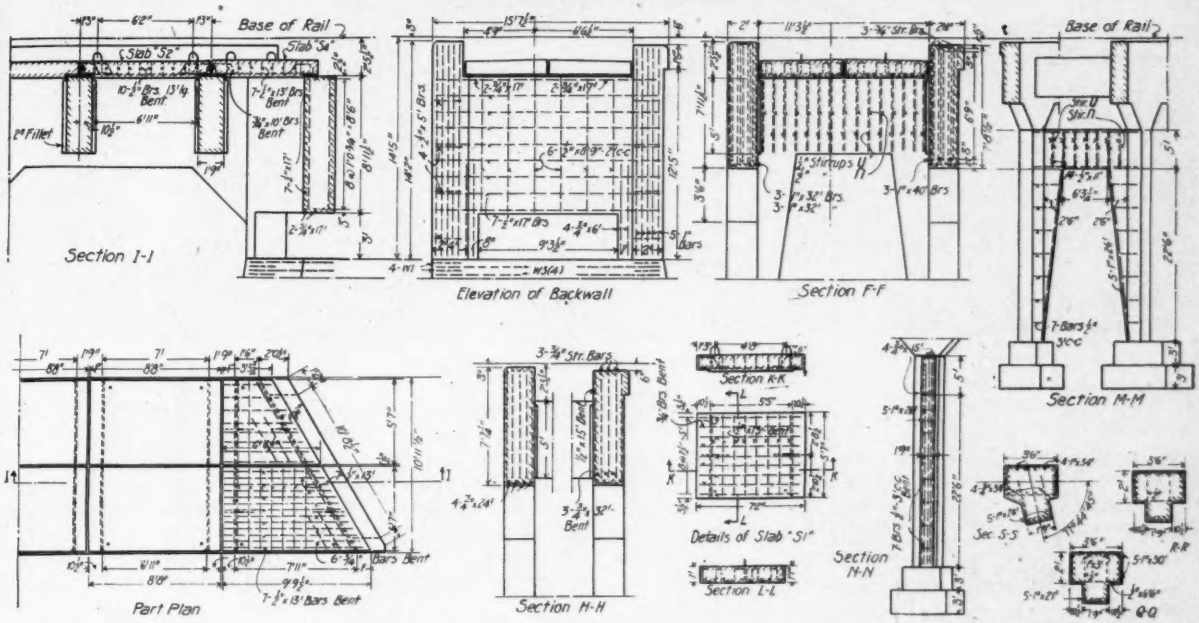


Fig. 11c. Details of West Abutment, Spokane River Bridge.

architectural treatment, and the appearance of these abutments is, aside from the fact that the spans of the side girders are a little too short, very satisfactory.

The complete success of this novel type of bridge abutments must be credited to its economy and adaptability even to the most unfavorable conditions. It is bound to gain importance if its use continues to be linked with considerations of safety, conservative design and expert workmanship and supervision.

Twenty Years Ago This Month

W. S. Moore is appointed acting engineer of maintenance of way of the Michigan division of the Big Four.

The Chicago, Milwaukee & St. Paul experiments with an electric lighting system of the axle-drive type, the invention of W. Biddle.

A. T. Dice, superintendent of signals of the New York Central, is appointed division superintendent of the Philadelphia & Reading.

Prof. W. D. Pence publishes a monograph on "Standpipe Failures."

I. O. Walker is elected a member of the Engineering Association of the South.

The jurisdiction of James Dun, chief engineer of the Atchison, Topeka & Santa Fe, is extended over the Colorado Midland.

The Engineering Association of the South discusses what are the best and cheapest culverts of areas under 50 square feet.

William Goldie wins an infringement suit against the Diamond State Iron Co., of Wilmington, Del. In the decision the court says, "the Goldie spike has met with universal public favor."

Prof. Edgar Marburg, of the University of Pennsylvania, in a paper on current practice in plate girders read before the Engineers' Club of Philadelphia, expresses the opinion that a limit-

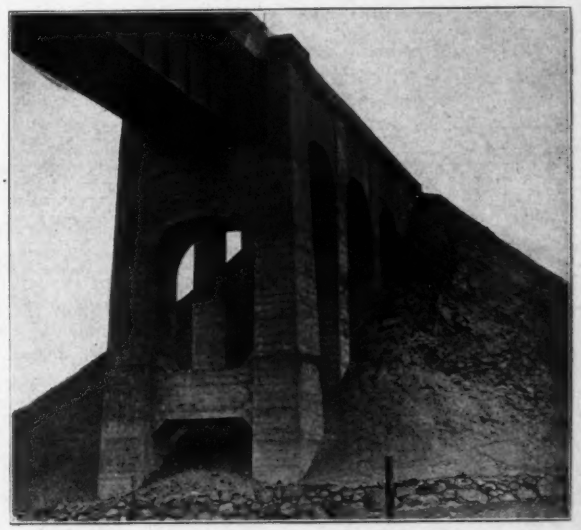


Fig. 16. West Abutment, Lind Viaduct, C., M. & St. P. Ry.

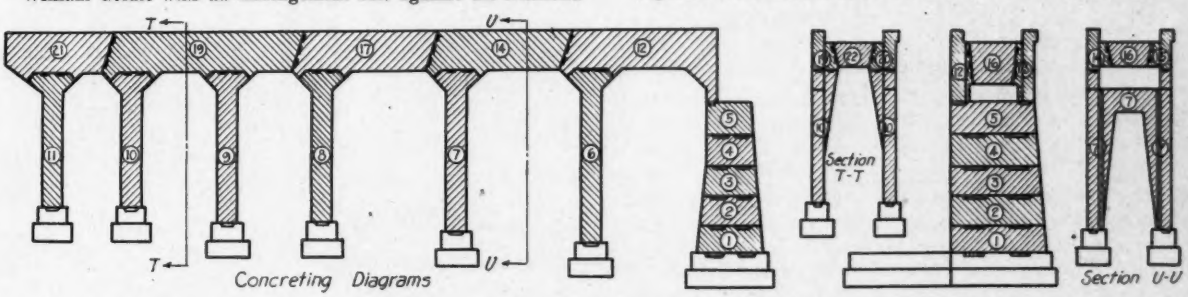


Fig. 12. Typical Concreting Diagrams, Spokane River Bridge.

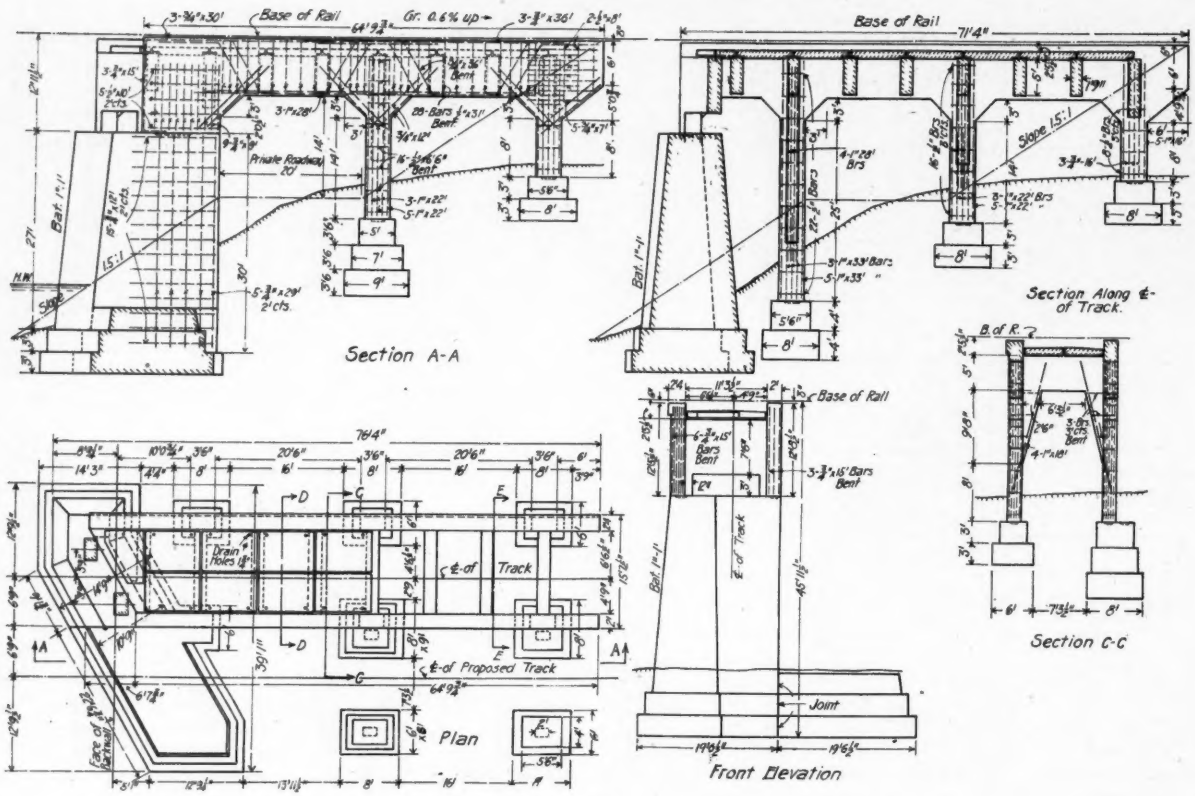


Fig. 13a. Details of East Abutment, Spokane River Bridge, C., M. & St. P. Ry.

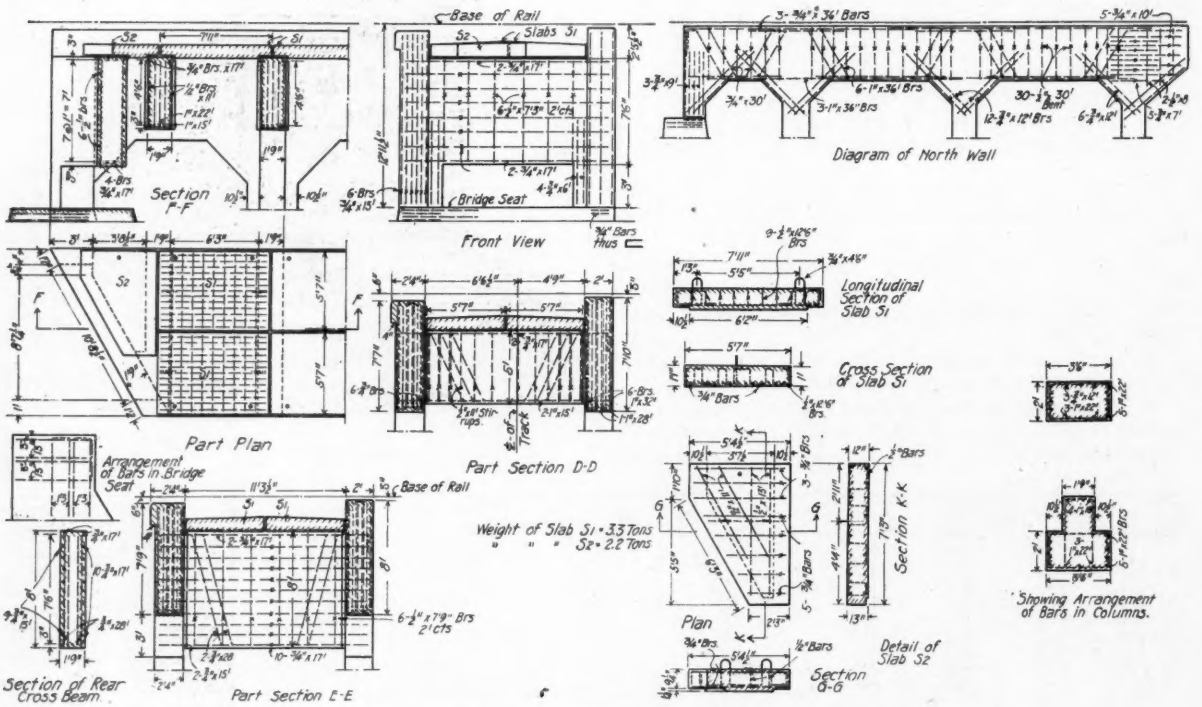


Fig. 13b. Details of East Abutment, Spokane River Bridge.

Fig. 14. Spokane River Bridge.

ing ratio of unsupported depth to thickness should always be specified, beyond which stiffeners should be required.

Isaac Burnett, for many years inspector for the Illinois Steel Co., enters the service of the Q. & C. Co., in charge of the application of Servis tie-plates.

The Baltimore & Ohio opens a new bridge at Harper's Ferry and a tunnel through Maryland Heights by means of which the line avoids the sharp curve which previously existed at the entrance to the bridge.

The New York, Ontario & Western is preparing plans for the reconstruction of Lyon Brook viaduct, near Norwich, N. Y., which is 820 feet long and 166 feet above the bed of the stream. It was originally built in 1869. Two schemes have been proposed as methods of construction: One is to build a traveler high enough and wide enough to let trains pass through during the progress of reconstruction; and, second, to build the towers and swing the girders from derrick cars on the existing track, the derrick cars to be side-tracked at the ends of the bridge when necessary to keep out of the way of traffic.

Dwight C. Morgan of the firm of R. P. Morgan & Son, engineers for the Illinois Railroad and Warehouse Commission, reports an inspection of the railways of Illinois. The report states that the railways in the northern part of the state have good ballast, because good gravel is abundant, but that in the southern part of the state gravel is scarce and ties are cheaper, and ballasting is not so general. The length of roads in the state is 10,427 miles, of which 94 per cent is laid with steel rails and 55 per cent is well ballasted. Signal structures, crossing signs and mile posts are in a very shabby condition and suggest the necessity of a law to punish those who wilfully mutilate them. Block signaling equipment is provided on 429 miles of track (not road).

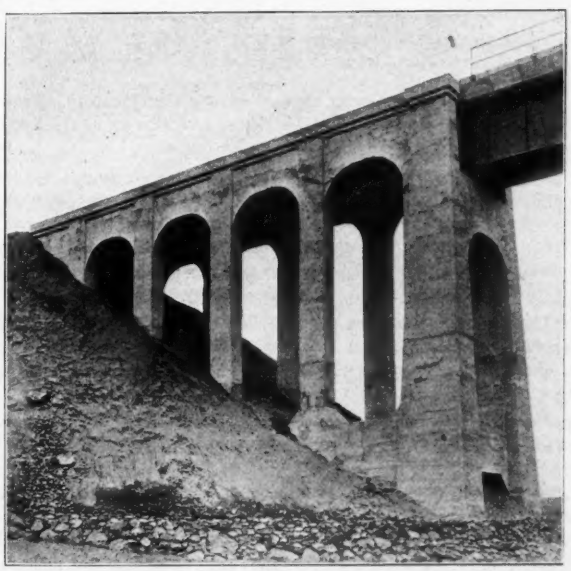


Fig. 17. East Abutment, Lind Viaduct, C., M. & St. P. Ry.

The Texas Railroad Commission (Messrs. Reagan, Foster and McLean), report a memorandum of the cost of a mile of track laid with 50-pound rails and of other weights up to 60 pounds.

The Standard Supply & Equipment Co. is organized to deal in construction tools and railroad and construction materials, second-hand rails, cars, etc. W. Barklie Henry is president.

*C. F. Loweth, of St. Paul, is engaged to prepare plans and specifications for a wagon bridge across the Mississippi River at Red Wing, Minn.

The Chicago, Milwaukee & St. Paul installs the manual block signal system on its line from Chicago to Council Bluffs.

The Pittsburgh Testing Laboratories issue specifications for steel rails so worded that each copy will govern the manufacture of a particular lot of rails.

F. B. Ward takes charge of the department of rail inspection of the Pittsburgh Testing Laboratories.

The Iowa legislature passes a bill governing interlocking at railway crossings, in which the provision is made that cases arising under it shall be brought before the district courts.

The Fitchburg Railroad issues a large volume of plats covering every detail of track structures along the right of way, ownership of abutting property, etc., from Boston to Fitchburg.

Walter Katté, chief engineer of the New York Central, announces the completion of the laying of 100-pound rail from Sputen Duyvil to Peekskill, 30 miles.

The Boynton bicycle railway, of which two miles have been built on Long Island, is tested for the benefit of a committee of the Massachusetts legislature.

President Roberts of the Pennsylvania Railroad denies that the road has any interest in the project to build a bridge across the North River and says that when the Pennsylvania goes into New York it will go underground.

The Hauss iron mail crane is placed at 23 stations of the Panhandle.

The London & Northwestern Railway adopts green for safety in signal lighting.

J. G. Mann, assistant chief engineer of the Illinois Central, is appointed general manager of the Mobile & Ohio.

W. G. Bailey, engineer maintenance of way of the Big Four, is appointed superintendent of the Cairo division in addition.

A four-track underground loop is suggested as the solution of the down-town congestion in Chicago, but engineers are skeptical as to how the soil underneath the city would adapt itself to the necessities of the case.

Morton L. Byers, junior of the American Society of Civil Engineers, reads a paper before that society on "The Removal of the Channel Pier of the Cincinnati & Muskingum Valley Railroad Over the Scioto River." The pier was wrecked by flood.

James C. Hallsted, of the firm of G. W. G. Ferris & Co., re-

*Chief engineer Chicago, Milwaukee & St. Paul.

moves from Chicago to take charge of the eastern business of the firm with headquarters at Philadelphia.

By a vote of 57 to 3, the city council of Chicago passes an ordinance requiring the Lake Shore & Michigan Southern and the Chicago, Rock Island & Pacific to elevate their tracks from Sixteenth street to State and Sixty-seventh and to Seventy-second street, respectively.

The New York senate committee holds a hearing on the bill presented by the railroad commission requiring the abolition of grade crossings.

W. E. Alexander completes arrangements for the manufacture of his recently invented car replacer.

The lift bridge over the Chicago River at South Halsted street, designed by J. A. L. Waddell of Kansas City, is completed.

M. J. Comerford is appointed roadmaster of the Lake Street Elevated Railway in Chicago.

C. L. Strobel is awarded the contract for the erection of a viaduct 4000 feet long and 60 feet wide at Sixteenth street, Milwaukee, for $182,000.

L. F. Loree, division superintendent of the Pennsylvania Lines West, delivers a lecture on "Track" before the engineering students of the University of Wisconsin.

H. W. Cowan is appointed chief engineer of the Union Pacific, Denver & Gulf.

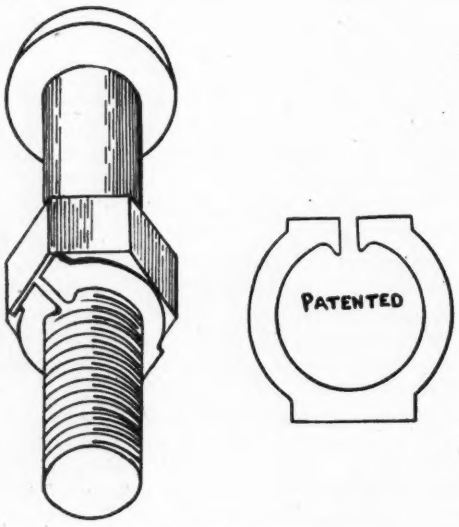
Charles J. Roney presents before the Western Society of Engineers a paper on the collective German engineering exhibit at the World's Fair.

The project for an elevated moving sidewalk to serve the loop in Chicago is dropped. The elevated railroads say they can take care of the business themselves.

HUNT NUT LOCK.

The Hunt Nut Lock will be exhibited at the Maintenance of Way convention in Chicago this month for the first time after a service test of 125,000 for two years on the Southern Pacific and other roads.

The Hunt Nut Lock is being manufactured and sold by Hubbard & Co. of Pittsburgh, Pa., and can be seen at their exhibit space, No. 315 and 316, Coliseum, Chicago. This nut lock is applied to the bolt after the nut is applied by simply screwing it along the threads of the bolt to its position firmly against the nut with an ordinary wrench, where it remains until taken off in the same manner as applied.



Hunt Nut Lock.

New Books

THE ELEMENTS OF SPECIFICATION WRITING. By R. S. Kirby, Professor of Civil Engineering, Pennsylvania College. Cloth, 6 x 9 in.; 125 pages. Published by John Wiley & Sons, New York. Price, $1.25.

A text-book on the art of specification writing and not a collection of so-called model specifications. The field for such a work is by no means limited to engineering schools, for there is much therein of value to the practicing engineer, the aim being to eliminate the continuous copying of specifications without due respect to the conditions at hand and to substitute therefor specifications which are the result of a study of each individual case.

The essentials of a valid contract and the significance of surety bonds are treated in a clear and concise manner. Following this the features of advertisements for bids, information to bidders and proposals are set forth. The chapter on composition of specification is one which contains much food for thought, regarding clearness of specifications and the writing of specifications, with an aim of fairness toward the contractor. According to the author fairness can only be obtained by guarding against the following faults: (1) Use of indefinite words and phrases, (2) throwing of all risks on the contractors' shoulders, (3) failure to warn the contractor (in the specifications) of any particular danger likely to be encountered, (4) putting clauses in specifications which are not meant to be enforced. How many specifications do we see where all these faults are eliminated? Not a vast majority by any means. Therefore we can justly say that the art of specification writing in its present state can be improved upon, which movement the author aims to, and no doubt will, give considerable impetus.

The treatment of general clauses occupies six chapters and specific or technical clauses two more. The chapter on outlines of specific clauses is designed especially to aid the student in the preparation of specifications on various kinds of work. The appendix contains a long list of classified references to recent articles on specifications in the leading technical journals. This portion is invaluable to the student and younger engineer.

The book is exceedingly well written in a most interesting and convincing manner and should enjoy an extensive popularity among engineers.

HANDBOOK OF RAILROAD EXPENSES. By J. Shirley Eaton. Flexible leather, 5x7 in.; 550 pages. Published by the McGraw-Hill Book Co., 239 W. 36th St., New York, N. Y. Price, $3.00 net.

This book deals with the separation and classification of railway expenses. The necessity for the use of this accounting and statistical analysis is well stated in the preface.

Each chapter and sub-division of a chapter starts out with a definition of the particular expense to be analyzed, or states accurately just what items go to make up the particular expense. Railway employes will doubtless find these painstaking statements of the items contributing to the expense of a certain kind of work, both interesting and illuminating.

The author holds that the I. C. C. Classification of railroad expenses is of importance to every railway official, and each one should be familiarized with the whole scale of operations, regardless of his department.

The classification of expenses is, of course, of more than usual interest to railway engineers now engaged or connected with valuation.

Nearly 200 pages are devoted to an exposition of the Interstate Commerce Commission Classifications, reprinted and abridged, but giving the essential text of these classifications. This feature, thus included, is put into very handy shape for ready reference.

The American Railway Engineering Association *

What It Has Done, How It Does It, and the Recognition It Is Receiving.

By Francis W. Lane.

Two years ago the writer contributed to this publication what was frankly confessed to be merely a sketchy account of the origin, early history and later development of the American Railway Engineering Association. By no means all of the great work of the organization was touched upon, nor was credit given to all of those who had worked long and faithfully for its success and growth. As the account purported to relate mostly to early history with which the writer had been intimately concerned from the start in October, 1898, it was not possible in even a fragmentary manner to touch upon the work as it is now being carried on nor to give anything like a complete summary of its work up to date. It is not possible to do so now, as its development is progressive; but it may be of interest to supplement the previous narrative, fill up some of the gaps and refer to some other features of the association's forward course.

What President Wendt suggested at the last year's convention in regard to the faithfulness of the board of direction is fairly characteristic of the whole membership. The distribution of this board covers from Winnipeg and Montreal on the North, New York and Roanoke on the East, Nashville and San Antonio on the South and Omaha on the West, and includes 19 busy men. Though so widely distant from Chicago, the regular place of meeting, and so busy, they all make it a point to attend the meetings of the board. "They are on the job." So are the rest of the members and so have they been at every meeting that has preceded this, the fifteenth anniversary of the formal organization of the association in March, 1899.

Perhaps it is this capacity for work that has been the reason for certain honors that have been conferred upon some of the members in connection with the physical valuation of railroads now being undertaken by the Interstate Commerce Commission. Two of the members of the board of direction, President Wendt and Prof. W. D. Pence, whose work as an engineer is no less worthy than that he has done as editor of publications for the association and in the engineering schools of Wisconsin and Purdue universities, have been appointed members of the engineering board in charge of this part of valuation work.

Frank Rhea, known in everyday life as a commercial engineer of the General Electric Company, has been appointed district engineer of the first district.

Among the assistant district engineers five members have been taken from this association: C. H. Spencer, engineer of yards and terminals of the Washington Terminal Company and chairman of the association's committee on Yards and Terminals, has been appointed assistant in the first district; W. G. Atwood, chief engineer of the Lake Erie & Western, goes to the second district. He was named as chairman of the committee on Uniform General Contract Forms. George H. Bremner, well known as engineer of the Illinois district, Chicago, Burlington & Quincy, treasurer of the association and chairman of its committee on Track, goes with Prof. Pence to the third district; B. J. Dalton, gives up his place as professor of railway engineering and surveying, University of Kansas, and goes as assistant engineer of the fourth district; and M. P. Paret takes up the work in the fifth district.

M. A. Zook, a member of the Committee on Economics of Railway Location, assumes the complicated duties of office engineer.

The appointees of the Commission are not the only ones who have their work cut out for them during the next few years on this same matter of valuation. Many of the roads have already named members of their own engineering staffs to handle valuation work on behalf of their respective companies. A. W. Carpenter, engineer of structures, New York Central & Hudson River, member of the committees on Conservation of Natural Resources and on Iron and Steel Structures, has been named to act for the road with which he is connected; L. S. Rose, who is a signal engineer and member of the Committee on Track, will act for the Big Four; A. L. Sarvey, assistant chief engineer Michigan Central, will act for his road; A. J. Himes, chairman of the Committee on Iron and Steel Structures, and whose excellent work in charge of grade elimination for the New York, Chicago & St. Louis at Cleveland forms the subject of one of the most interesting monographs in the publications of the association during last year, will act for the Nickel Plate; Charles S. Churchill, one of the wheel horses of the association, past president, member of the committee on Rail, is chairman of the committee on Valuation of the Norfolk & Western, upon which road his efficient services have recently been recognized by promotion to the position of assistant to the president; J. B. Berry, another member holding the position of assistant to the president and whose work for the association has been among the most valuable of the contributions of the busy men to the common good of the railway service, will act on valuation for the Chicago, Rock Island & Pacific; George H. Burgess, chief engineer of the Delaware & Hudson and member of the association's committee on Yards and Terminals, will serve his road in this capacity, in addition to his regular duties; H. L. Ripley, who in ordinary life has been a contracting engineer at Brattleboro, Vt., will help the Commission find out the hidden values of the New York, New Haven & Hartford; S. B. Fisher, chief engineer of construction, Missouri, Kansas & Texas, member of the association committee on Roadway, will help ascertain some of the values he has put into that road; W. C. Cushing, who has had all the honors of the association and done something more than his share of the work, and W. D. Wiggins, superintendent of the Vandalia, will look after this work on the Pennsylvania system; D. W. Lum, now consulting engineer of the Norfolk & Western Railway, but who was for many years of the engineering department of the Southern, will follow the progress of valuation for the latter road; and William McNab, without whose presence it would seem impossible to hold a convention, who, like Cushing, has had all the honors the association can bestow, and who is now a member of the committee on Ballast and chairman of the committee on Conservation of Natural Resources, will serve the Grand Trunk Railway in this capacity, in so far as the lines of the road come under the jurisdiction of the Interstate Commerce Commission.

Whether these appointments are in the nature of honors or simply a recognition of engineering capacity, matters little so far as present purposes are concerned. The selection of these particular men, who have shown in their work for the association perhaps as clearly as in their daily routine that they are capable of taking care of any work that may be put upon them, indicates that the roads by which they are employed recognize in them the natural appointees for this arduous and highly important work.

Though, as Commissioner Prouty has said in one or two addresses he has made on the subject, the matter of valuation of railroads as it will be taken up under his direction is no mere engineering problem, there is enough of engineering in it to keep many able engineers busy for many years. Preliminary to the actual work of the Commission's bureau, or whatever it may eventually be called, every railroad must furnish to the commission maps and plans that will identify its property. A few roads now have such plans; many have not. Many have maps and plans that furnish part of the information that will be required, but not the whole, and in most cases what they have is not in the form in which it is required that it be presented to the Commission.

Where no maps or incomplete maps exist, new ones or additions will be required and something of what this means may be

* Copyright, 1914, W. E. Magraw.

gathered from Commissioner Prouty's statement that when this part of the work is completed there will be in the office of the Commission an accurate map and inventory of the property of every railroad engaged in interstate business as of June 30, 1914.

This evidently will keep our railroad appointees to this work busy for a period; then Wendt and Pence and their corps of assistants will have employment in finding out what it all means.

Mr. Wendt, in his important committee work for the association over which he now presides, has demonstrated his capacity for the accurate performance to the smallest detail of the class of work of which, as intimated, there will be an ample supply. His systems of records, reports and accounts of work in progress have received the highest commendation from railway engineers and the same kind of capacity will be of great value in determining the cost of work that has already been done. As some one in this connection has stated:

"He is in charge of engineering work of the Pittsburgh & Lake Erie, which is one of the best little old railroads in the world, paying anywhere from 10 to 50 per cent on its capital stock."

In the previous article on this same subject, relating, however, as stated, more particularly to the historical feature of the association, the present writer referred to the connection of the association's first active president—he was active, too, was John F. Wallace—with the work of building the Panama Canal. The pioneer work he did has since been somewhat overshadowed by the work of his successor now in office, but doubtless no one sooner than Col. Goethals would recognize the efficiency with which those pioneer tasks were performed. It was stated in that article that doubtless the canal would have been dug had the American Railway Engineering Association never existed; it is doubtless equally true that the work has been better done than if such had been the case.

This statement is emphasized by the fact that four names, not mentioned in the previous account, are closely associated with canal work. John G. Sullivan was assistant chief engineer when John F. Stevens was at the head, and, unless tropical influences overcame some of his native characteristics, he probably contributed something besides engineering knowledge to the gaiety of life in the Zone.

W. E. Dauchy was for a considerable period resident engineer in the Canal Zone, as was also A. S. Zinn, who on account of his long absence from the States stands no show against Zook for gaining the distinction of ending the line in the list of members and in the latter strife is closely pressed by Ziegweid, Ziesing and Zinck.

Not exactly on canal excavation or equipment, but engaged on a very important part of the organization, was Hiram J. Slifer also, member of the committee on Roadway, and now a consulting engineer in Chicago. He was manager of the Panama Railroad—a remarkable instance of successful government ownership.

One more classified group it may be worth while to introduce: Those engaged in the construction of transcontinental railways. Railway construction, for divers well-known reasons, has not been a specially compelling activity for the last few years except in three notable instances. There have been recently no notable instances of reconstruction. But it would be unfair to pass without mention the service of H. A. Woods, assistant chief engineer Grand Trunk Pacific; H. H. Brewer, general superintendent of the same line; H. R. Williams, president; E. J. Pearson, chief engineer; C. F. Loweth, consulting engineer, all of the Chicago, Milwaukee & Puget Sound, as well as W. L. Darling, now chief engineer Northern Pacific, but formerly connected in his professional capacity with the Milwaukee's Pacific Coast extension. Virgil G. Bogue, consulting engineer, New York, alone sustains the association's connection with the remaining new transcontinental line, the Western Pacific. All the above-named are members of the association.

In an account which Secretary Fritch has prepared at the suggestion of the Board of Direction, in honor of the fifteenth anniversary of the organization, it is shown that the membership is steadily on the increase, thus indicating, not necessarily that the newer members are getting in line where possibly the lightning of government or official preferment may strike them, but rather recognizing the benefit that must come to them educationally as individuals from their connection with so substantial a body of fellow-workers. The total membership on January 1, 1913, was 1,066. At the close of the convention in March of that year it was 1,115. At the present writing there are 1,210, and the territory covered and the distribution are as follows outside of the United States:

Canada, 94; Japan, 8; Mexico, 5; Central America, 5; New Zealand, 4; China, 3; Cuba, 4; Philippine Islands, 2; India, 2; Argentine Republic, 2; Brazil, 2; Peru, Ecuador, Bolivia, Panama, Porto Rico, Russia, Uruguay, Haiti, Costa Rica, Hawaii, 1 each.

The membership, officially stated, includes presidents, vice-presidents, general managers, general and division superintendents, chief engineers, principal assistants, engineers of maintenance of way, division, bridge, signal and assistant engineers, professors of railway and civil engineering, etc.

Requirements for active membership call for five years' experience in location, construction, maintenance or operation of railways, engineers in responsible service, and professors of civil engineering. There is a provision for associate membership which will admit engineers in contracting service, instructors in engineering in colleges and universities and representatives of industrial corporations whose duties are purely technical.

The association issues three publications: Monthly Bulletin, Annual Volume of Proceedings, and Manual of Recommended Practice. The first-named contains reports, special papers contributed by members and others and items on association affairs. The Proceedings contains reports and discussions, written and oral, in full; and the Manual covers definite statements of principles and practice. During the last association year the publications covered a total of 35,186 pages; Bulletin, 17,519; Proceedings, 15,241; Manual, 1,380; other miscellaneous matter making up the remaining pages.

The memberships are entirely individual, i. e., not representative of the railroad by which the member is employed. There is no entangling alliance with supply interests, owing to the definite position taken and announced at the first meeting, that the important functions of these interests were recognized, but it was deemed better that each interest should stand on its own bottom. The association welcomes the members of the supply fraternity as guests, and will visit their exhibits; but the board of direction recognizes that the association was formed for hard work. The principle has been followed rigorously.

It may be proper in this connection to revert to a personality, relating to a committee which forms the connecting link between the association and the National Railway Appliances Association, embracing the supply interests. President Wendt, in accepting last year the office to which he had just been elected, referred to the efficient work of Frank R. Coates, president Toledo Street Railways, as a member of the committee on arrangements and entertainment, as entitling him to a life tenure of office at an increased salary. J. B. Cox, who has served for a longer term than Coates upon the same committee, understands that the increase in salary amounts to free tickets to the banquet. Though his membership number is 23, Cox still declines to take the action suggested by the cabalistic figures, because, in discussing Hotchkiss' election to the presidency of the Illinois Tunnel Co., and as a director of the Virginian Railway, he attributes this phenomenal rise to the fact that Hotchkiss served on the committee of arrangements, including entertainment, the year of the first convention. Both Coates and Cox, from their seniority in this service, are looking for similar strokes of lightning.

The announcement of E. H. Fritch's re-election as secretary at an increased salary was received with such applause as to kindle a hope that his increase is more substantial than that awarded to the committee of arrangements and the hope is supported by the knowledge that Fritch has already bought his ticket.

In a rambling account like the present this seems as good a place as any to refer, as did President Wendt in his address of acceptance, to T. E. Crossman and George W. Burgoyne, official stenographers who, having served in that capacity for 13 years, are entitled to rank as associate members. But these personalities take us away from the main line of thought.

Probably the influence of the association is no better illustrated than by reference to the frequent request for co-operation with other technical organizations which results in mutual benefit. Among those societies with which the association has worked most effectively are: The American Railway Association, which has turned over to the A. R. E. A. its entire interest in investigating the rail question; the American Society for Testing Materials, American Society of Civil Engineers, Master Mechanics and Master Car Builders' associations, the Railway Signal Association, which works closely with the superior association; the Association of Portland Cement Manufacturers, and others. The association is represented on the National Advisory Board for Testing Materials, appointed by the President of the United States, and had an official representation at the conference on Conservation of Natural Resources, convened by invitation of President Roosevelt.

The association now has four standing committees in addition to the 14 originally provided for. These cover the subjects: Economics of Railway Location, Wood Preservation, Electricity and Conservation of Natural Resources. From time to time special committees are appointed, including such subjects as classification of track; injury to signals, track and bridges, due to brine from refrigerator cars; impact tests, uniform general contract forms; allowable limit of flat spots in car wheels; lumber grading rules.

Prior to the organization of this association there was little uniformity in methods and practices, even where conditions were similar. The association is filling a broad field in the way of harmonizing practice and the statement of principles ennunciated by the present president—Unity in Essentials, Liberty in Non-essentials, Broad Charity Toward Present Standards—might well be taken as a slogan.

Collectively, as committees and in convention, individually, in papers published from time to time in the Bulletin, the association is little by little crystallizing the best principles and practice in comprehensible form. In committee work the members first ascertain present practice so far as may be. This information is analyzed and digested and then, from the data obtained and the personal knowledge of members of the committee, recommendations are prepared for adoption by the association as recommended practice.

Committee reports cover: (1) Definitions, if not previously established, from the professional standpoint only; (2) History—origin and development; (3) Analysis; (4) Argument in favor of practice recommended; (5) Conclusions. That the method leads to excellent results seems to be demonstrated by the high standing of the association's publications in engineering offices, private enterprises, national government affairs, and as text-books in engineering schools.

At a meeting of the board of direction on November 20, 1913, it was announced that a committee of the American Society of Civil Engineers had been appointed to co-operate with a committee of this association to conduct tests on stresses in track and also that through the efforts of W. W. Dawley, President J. J. Farrell, of the United States Steel Corporation, had offered to subscribe $10,000 for this purpose and that through Vice-President J. C. Stuart the Erie Railroad had offered track and facilities for the same purpose.

These are among the committee achievements and accomplishments of the board of direction. Individually, no less zeal has been shown in the cause and the results contributed to the association. During the last year or two some notable papers have been added to the results achieved by committees. L. C. Fritch, first secretary and past president, chief engineer Chicago Great Western, presented an exhaustive treatment of the subject, "The Storage Battery in Railway Service," thus recognizing the present and probable future greater importance of the consideration by the association of electricity as a motive power. Recognition has been made by the addition of this subject to the list of those in charge of standing committees. In October, 1912, C. E. Smith, bridge engineer Missouri Pacific, contributed a copiously illustrated paper on "Bridges Over Navigable Rivers."

Perhaps one of the most comprehensive documents of this kind, involving a vast amount of actual research, is the report of a series of dynamometer tests made on the Baltimore & Ohio by R. N. Begien, assistant general superintendent of that system, and appearing as a part of the report of the committee on economics of railway location, in January, 1913, and considered in convention last year. In the introduction to this report and by way of explanation, the author says: "The number of formulae (for train resistance) in use only serve to inspire a serious doubt as to the accuracy of any of them. * * * Some dynamometer charts have not been properly studied, but there are also many unknown factors which make the interpretation of the charts difficult. * * * Results obtained seldom agree with the preconceived notions of those who use them, causing modifications and amplifications of a more or less 'practical' nature. The verdict is, generally, that the only way to make a rating is to try different loadings until the correct one is found and then use it. This method would be all right if the loading adopted as the result of such trials was a proper one for all conditions of cars and condition of track and weather. There is also a difference of opinion as to what constitutes a correct rating. It is a mistake to suppose that proper ratings depend entirely on the power of the locomotive and the grade; yet the ideal condition is realized when such facilities for handling trains are supplied that those two factors control the rating. * * * Since the object of tonnage rating is to establish a standard by which performance may be measured, it is better to predetermine that standard than allow each one to make his own."

The tests covered by this report were carried on from October, 1910, to January, 1911. The preparations for undertaking them were made with the utmost thoroughness and the data and diagrams are comprehensive and complete.

C. P. Howard, consulting engineer, Chicago, furnished a paper on "Grade Reduction Problems," and George H. Kimball, now consulting engineer at Detroit, presented an elaborate treatment of the subject, "Unification of the Freight Terminals of a Large City," based upon conditions at Buffalo. Prof. J. C. L. Fish, Stanford University, offered a scientific treatment of "Extra Top Width for New Fills."

"Elimination of Grade Crossings of the New York, Chicago & St. Louis in Cleveland," was elaborately treated in the Bulletin for October, 1913, by A. J. Himes, engineer of grade elimination, and as a part of or appendix to the report of the committee on rail, H. B. McFarland, engineer of tests of the Atchison, Topeka & Santa Fe, treated of the "Influence of Seams or Laminations in Base of Rail on Ductility of Metal," and Max H. Wickhorst, whose work as engineer of tests for that committee is notable, considered "Seams in Rails as Developed From Cracks in the Ingot." A report from the same investigator to be presented at the present convention covers, "Influence of Aluminum and Silicon on Bessemer Ingots and Rails" and "Specifications for Carbon Steel Rails," are covered in the same connection.

"Air Seasoning of Timber," is handled in a recent Bulletin by William H. Kempfer of the Forest Products Laboratory, United States Department of Agriculture, and Dr. Herman von Schrenk gives a report on "Use of Refined Coal Tar in the Creosoting Industry."

A decidedly practical subject is comprehensively treated by H. B. McFarland in the way of a report of tests on "The Holding Power of Goldie and Cut Spikes." But lest this resumé assume the character of Homer's "catalogue of the ships," it is better to desist.

Though the king is not officially dead yet, it may not be out of place to hail, in a tentative and restrained manner, the coming

incumbent. At a meeting held to consider the officers to be elected for the ensuing year, the following names were proposed by the nominating committee:

For president, W. B. Storey, vice-president Atchison, Topeka & Santa Fe; vice-president, A. S. Baldwin, chief engineer Illinois Central; secretary, E. H. Fritch; treasurer, G. H. Bremner; directors (3 to be elected), Curtis Dougherty, chief engineer Cincinnati, New Orleans & Texas Pacific and Alabama Great Southern; H. E. Hale, engineer maintenance Missouri Pacific; John D. Isaacs, consulting engineer Southern Pacific; C. E. Lindsay, division engineer New York Central; J. C. Mock, electrical engineer Detroit River Tunnel Co.; R. Montfort, consulting engineer Louisville & Nashville; G. J. Ray, chief engineer Delaware, Lackawanna & Western; C. H. Stein, engineer maintenance of way Central of New Jersey; Earl Stimson, engineer maintenance of way Baltimore & Ohio.

Since the association has continued to recognize the exhibit of the National Railway Appliances Association as an educational adjunct, it may not be amiss to state that the attendance at the exhibit last year was in the vicinity of 50,000, and it has been stated that some railroad companies send their roadmasters a distance of a thousand miles for the benefit to be derived from this feature alone. One division engineer arranges for supervisors and section foremen to attend in groups on different days under a leader who is expected to make a written report on his return home. The capital represented by the lines of business making exhibits last year was estimated at $495,000,000.

To one who has had sufficient interest to read thus far, it will be plain that the entire purpose of the organization is a serious one. There is little occasion for pleasantry in reviewing what it has done or what it is going to do. It started out fifteen years ago as a full-grown entity so far as capacity for a man's work is concerned. It has developed along the same line to a stature almost gigantic. To the members themselves individually, collectively as committees and as willing workers under a capable board of direction, is due the bulk of the credit. Yet it would not be fair to the judgment of the members in the election of their leaders, nor to those leaders themselves, to fail to award the highest degree of praise to those who have stood at the head of the organization and to a degree guided its development for fifteen years—live wires, all of them, as Secretary Fritch says—Wallace, Kittredge, McDonald, Kelley, Johnston, Berg, McNab, Fritch, Cushing, Churchill—and now Wendt. "There were giants in the land in those days," and there are now.

The Interpretation of Experimental Data *

J. G. Van Zandt, C. E.

One of the principle causes of disputes over the true values of some of the vital elements of the Economics of Railway Engineering, has been the difference in the methods used in the interpretation and adaptation of the data found. In many cases expensive, careful tests have been made and the data plotted graphically upon a coördinate diagram, and then their value has been lost by having a straight line or "an average curve" drawn through them which is taken for the result of the tests. This has been particularly true as regards train resistance and tractive power data which are necessarily used as the basis of economic estimates involving large investments.

It is the purpose to set forth herewith some of the fundamental rules of mathematics involved in the correlation and interpretation of data for the guidance of those who have valuable data and desire to secure its correct interpretation.

I—The Nature and Peculiarities of Experimental Data.

(a) Exact values: At the very outset it must be understood that no experimental values are absolute or "exact" and that "true values," are forever unattainable. An approximation can be found, however, and by the laws of probability the probable error can be estimated, though it is not known whether this error is positive or negative. It is the purpose here to find methods which will conduce to the reduction of this error to a minimum and thus secure the most accurate result.

(b) Natural Laws: There has been a common misunderstanding, which has been the unstable basis of many erroneous conclusions, that under the same or nearly the same conditions the laws of nature always produce identical results. To those familiar with biological science this basis is evidently untenable and it is well known that, while generally speaking the principle is approximately true, a single observation is very likely to give anything but the true value desired. In hydraulic experimentation taken with machinery, pipes, and all equipment as nearly the same as it is possible to make them, it has been found that the co-efficients computed from observed readings are not always identical, as might be expected. The reasons for the variations are many and include not only the "personal equation" of the observers but the combination of slight variations in many of the conditions of the tests. Mathematics is the only so-called "exact science" and yet there are in mathematics indeterminate values and series whose exact values have never been obtained. The fact therefore remains that while the laws of nature are unquestionably inexorable, nevertheless there are undeniable evidences that these laws operate under the rules of probability and chance, and for this reason observation of a limited number of experimental conditions can never reveal their true values and *only by a careful study of a large number of observations can an approximate value of reasonable reliability be secured.*

In rolling one hundred coins down an incline onto a level floor it is found that some roll farther than others, some turn over on one side, and some on the other, and the net result is that while they all received as nearly the same start as possible, there are many different positions occupied at the end. The laws of gravity, of energy, and of friction were all at work but chance also played its part. It has been found that the number of "heads" or "tails" follows definite law of probability and that when other things are equal and the number of coins used is large enough, there is a remarkable agreement with the theoretical determinations. In railway operation a given locomotive is fired with coal by hand and while the fireman may endeavor to do his work in the same manner at all times, the chances are that there will be slight differences and the combination of all the slight differences in any test may alter the result appreciably.

(c) Compensation: There is a law of compensation which fortunately operates to keep an average result more uniform because one destroying influence may be in part counteracted by another which tends to increase the value, thus in a measure neutralizing the effects. But by the laws of probability there would be times when these conditions would all tend in one or another direction so that the net result is very different in some individual cases, from the value desired.

(d) Averages: Unfortunately the impression is often made by an array of data that its interpretation is a hopeless task. Recent publications state that the exact value of train resistance, for example, can never be found, which is, of course, true and accepted by everyone. But this does not justify anyone in proceeding to make bold assumptions and in striking general averages simply because the exact value is unknown. It would be just as unscientific to take a general average of all data and use this as a basis of investigation as to state that, since the exact value is unknowable, therefore there can be no basis. The right and reasonable basis should be made on a careful study of the available and thus by approved methods would be found *the most nearly exact value that the data will produce.*

*Copyright, 1914, W. E. Magraw.

This does not mean that *refinements* will be made of a result easily obtained with reasonable accuracy by shorter methods, but does maintain that the *true result itself*, or the very fact that there is a correlation of the observed phenomena, can never be surely known without such study. In fact there have been occasions where observed data appeared to give a result, which a careful study showed unquestionably did not really exist at all. It might be observed that the number of inches of rainfall had increased directly with the average temperature. It might be shown by a careful study of the data presented that this happened to be the case in this instance but in many others the reverse was found and apparently there was no correlation. Again, it might be found that the coal consumption on a certain division had increased in exact proportion to the number of tie renewals—but the apparent correlation could be proven not to exist in fact, but just happened to appear true in this one case. The most exact value is the only one which may be justifiably used and it should not be discarded until new data is available which may present a more exact value on account of the larger number of observations employed.

The use of averages is never justifiable except for the most approximate and unimportant determinations. The assumption that the average of the series of readings is an index of the trend of the determination is misleading and unreliable. There is no doubt that a carefully selected series of readings of nearly the same value under conditions nearly the same and not involving extraneous influences will be permissible but when the values cover a wide range of differences and include more influences than those indicated in the readings, averages should not be used. The train resistances of all kinds of cars and track when plotted on a coördinate diagram almost cover the whole diagram. If an average of all these values is taken we might find the one value of 7.8 lbs. per ton. Evidently this is not a correct value for use at all speeds with cars of all kinds and sizes. Again, if by drawing a straight line across the diagram which has as many points above as below, we may find a line of uniform value for all speeds and cars; such a result is equally unreliable. It seems evident that all of these results are unreliable for any scientific investigation and yet, incredible though it may appear, striking examples of this very nature are to be found. The confusing and unreasonable results of these determinations should not be unexpected under these conditions. Averages have their value in the computation of results but *should not be used as the results themselves*, since they are based on the unreasonable assumption that all factors have equal correlation and all values are equally important no matter how extreme or unusual they may be. If all possible values were thus related and happened to appear symmetrically about the true value, then the average would be identical with the true value, but such is a practically impossible condition and cannot reasonably be assumed to prevail.

(e) Other Common "Short-Cut" Methods: The method of plotting a curve having an equal number of points on each side, or plotting the "average points," is open to similar criticism for similar reasons, and for the additional reason that it does not give consideration to the "distance from the curve" to these points. In the discussion of the methods used in one case the statement was made that after a number of values had been studied which gave an array of points in the diagram, a straight line "seemed to fit the points as well as any." To get at the true value some have sought to take "moments" about this "trial curve" and multiply the number of points found at a certain distance away by the ordinate distance (sometimes the normal perpendicular distance) and thus adjust the "trial curve" to these computations so as to arrive at a curve which most nearly fulfilled the conditions of "weighted" points or moments about the curve.

Another method often used but equally unscientific and unreliable is that of taking "sections" thru the diagram and finding the average for that section and then reducing the total number of points until a final result is obtained.

None of the above methods can be in any measure a reasonable one since the fundamentals of the mathematics involved in recognized statistical methods are flagrantly violated. Any method for securing even an approximate result of reasonable reliability *should first of all determine the correlation of the factors involved*, for there may be apparently a relationship, which may be shown to be so small as to have no value whatsoever. If there is shown to be a reasonable correlation between the factors or if only one factor is to be considered, then the variation should be studied to ascertain what would be the "probable error" of the determination from the data at hand. If this should prove too great an error for the use desired further tests should be made or the limits of the variation reduced until the desired accuracy is obtained. Upon finding the variation capable of reduction to a result with permissible error, then a study of the rejection of extraneous values should be made and all this should be done with due caution in accordance with the scientific and mathematical formulas available for the work. If approximate values with larger error can be used, the labor involved may be saved by simply using all values found.

The processes which should be used are given in detail under a following paragraph but it may suffice here to state that the methods used and computations necessary are more complete than in any of the above mentioned "short-cuts." It is probably on account of the extra computation involved that there have been so many who have been willing to sacrifice the end obtainable, thinking that it was an "unnecessary refinement." *As a matter of fact it is not a "refinement" at all, but the only way of arriving at the true significance of the data at hand.* It is obviously better to take the necessary time to secure the true meaning of the data than to take what may appear superficially without this determination and use that result, which is most often erroneous, as the basis of computations involving large investments. It is no wonder if the returns from those investments are often not near as large as expected. It is not the purpose here to set forth an exhaustive mathematical discussion of this subject, but the formulas suggested may be found in any standard textbook on the mathematics of statistical methods and the "theory of least squares." Only a practical method of applying and using these formulas will be given in the following paragraphs.

II—Fundamental Principles in the Interpretation of Data.

(a) Definitions: In order to systematize the handling of experimental data it will be necessary to adopt some abbreviating terms and indicate them by letters which may be used in a formula. For this purpose the following definitions are suggested:

(1) A variate (v) is a single magnitude, determination, or single observed value of any quality common to a number of individual units; for example, the weight of a car or a single observation of speed of a locomotive.

(2) A class (c) includes variates of nearly the same value which fall within its limits; for example, cars weighing from 15 to 16 tons, or speeds ranging from 25 to 26 M. P. H. These classes may be taken at the average value, multiplied by the number in the class, to include all its variates, thus saving the separate computation of the odd fractional values where this refinement would not be justified by the character of the tests. The class range or difference between limits (d) is frequently unity.

(3) Variation (R) deals with the diversity in the many characteristics of the individual units or of functions of these units, for example, variation in the wear of brake shoes of different kinds, or of the same kind under different conditions, or variation in coal used per pound of steam with different kinds of grate bars or with the same kind under different draft conditions.

(4) Seriation (S) consists in the grouping of variates into a series of classes, for example, freight cars weighing 14.1, 14.3, 14.7, 14.9 tons respectively may be seriated into two classes, the first for cars of 14.0 to 14.5 and the second for cars of 14.6 to 14.9 tons inclusive.

(5) The frequency (f) represents the number of variates in a class, for example, in the above seriation the number of variates was two in each class, hence we say f=2. If there had been seven in the first class and twenty in the second and one hundred and forty-six in the third and so on, we would write in the same way, f_1=7, f_2=20, f_3=146, etc. The total frequency or sum of all the frequencies is the total number of variates (n) hence we write $\pm f = n$ or "summation f equals n." In the first case n = 4 and in the second illustration above n = 7+20+146 or n = 173.

(6) The mean or average (A) is found by the formula:

$A = \frac{E(V.f)}{n}$ in which "V" is the mean value of the class or half the sum of its limits. *Example:*

Classes	1.	2.	3.
Limits	15.0–16.0	16.0–17.0	17.0–18.0
"f"	20	170	40
"V"	15.5	16.5	17.5

applying the above formula,

$$\text{"A"} = \frac{15.5x20+16.5x170+17.5x40}{20+170+40} = 16.587$$

(7) The mode (M) is the class with the greatest frequency; for examples, in the above illustration class 2 is the mode though of course usually there are several hundred classes and the result is that sometimes there are several classes with the same number of variates in which case the middle one is the "empirical mode" but the "theorretical mode" is the corresponding ordinate of the "normal curve" agreeing with the observed distribution of the variates. The mode may be found by the formula, M = 3m — 2A. If the values of "f" are plotted graphically as the ordinates using some characteristic of the variates as abscissae the result is called the "frequency polygon" and shows the distribution of the frequencies. Enough tests must be made to secure a sufficient number of variates so that there will be many sides to this polygon and it is evident that the more there are, the more nearly will this polygon approach the "normal curve" the formula for which is:

$$y = \frac{n}{\sigma\sqrt{2\pi}} \times \frac{1}{e^{\frac{x^2}{2\sigma^2}}}$$

In Figure I this curve is shown in the diagram with the frequency polygon of an actual series of observations superimposed. By the use of this normal curve, data may be supplied theoretically which would normally be found with a larger number of variates. Any extreme conditions in the polygon indicates insufficient number of variates or the influence of extraneous factors which should first be eliminated. Values outside of the normal range of probability can be investigated and often it will be found that unusual conditions prevailed or mistakes were made in the computation of that value. It is evident then, that we can correct our observations by finding what variates would not normally fall within the range of the problem in hand.

(8) The median (m) is that value above and below which an equal number of variates occur, for example, in a case of 845 variates arranged in the order of their values, variate number 423 would be the median as there are 422 on either side. The theoretical value of the median is found by the formula:

$$m = \frac{2A-M}{3}$$

(9) The deviation or departure of a class (D) from the mean is the difference between the mean and the value of the class; for example, if the mean of a series of variates is 22.1 then the "D" of class number 1. with value 15.5 is:

D = 22.1 — 15.5 = 6.6

(10) The standard deviation (σ) or index of variability is a convenient constant for use in the correlation of variates and is found by the formula:

$$\sigma = d\sqrt{\frac{E(x^2f)}{n}}$$

(11) The Probable Error (E) is the measure of unreliability of the determination. There is an even probability that the true value lies within the amount of this error above or below the value determined. For example the probable error of the mean is found by using the formula:

$$E = \pm 0.6745x\frac{\sigma}{\sqrt{n}}$$

In explanation of some of the above items it should be stated that while the terms are necessary they have no intrinsic values and are not complicated nor difficult to handle when used often by one accustomed to statistical problems. For example, in the seriation of the variates the classes may be chosen with such limits as will give a most normal distribution, always having the same range of course, but the work is thus simplified by adjustment of the limits securing a better working basis.

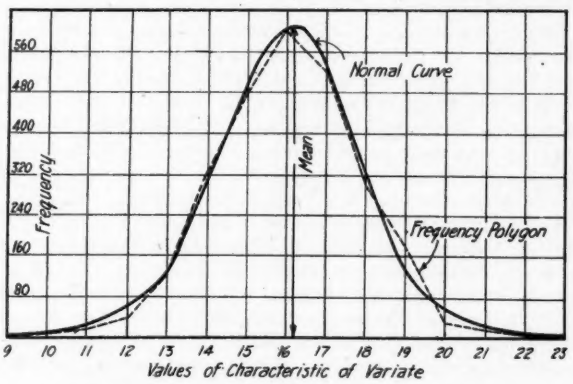


Fig. 1. Interpretation of Experimental Data.

Important Fundamental Principles.

(1) The probable error of the result depends upon the number of variates and varies inversely as the square of the number of variates taken. In other words, twice the number of values gives an average four times as accurate and three times the number of values gives an average nine times as accurate.

(2) The probable error decreases as the standard deviation increases so that in tests covering a wide range the results are not so accurate as those covering a more limited range. In other words, if the same degree of accuracy is desired for a determination of twice the range then four times as many variates must be taken; for example, if a series of dynamometer tests of train resistance was taken for speeds from ten to fifteen miles and a result from 2,000 tests was found, and it was desired to secure values extending to twenty miles per hour of the same degree of accuracy, 6,000 additional tests should be made making a total of 8,000 tests to give the same degree of accuracy to the results. By "accuracy" is not meant "exact value," but the degree of reliability of the manner of variation of the value with given changes of the value of the characteristics.

(3) The probable error varies as the number of factors involved in the variation, it being very desirable to separate all influences from the ones under study; for example, in a test of boiler efficiency observations should be taken by the same observation crew (personal equations) under the same conditions of draft, fuel, etc. Changes will be sure to introduce new factors which will so affect the results that normal distribution will not appear in the seriation and the probable error will become excessive.

NOTE.—In a subsequent issue the author will present the practical rules of procedure for the interpretation of experimental data according to principles outlined.

The Location of Construction Joints in Concrete Work.

IT IS very often desirable to have the concreting of a structure done continuously, but, due to various conditions, this may be impossible and construction joints must be used. In such cases the joints are many times placed just where they are most undesirable, due to the lack of technical knowledge of the foreman in charge.

The designer of structures is in nearly all cases more capable of locating suitable points for construction joints than the ordinary man on the job, and for this reason all construction joints should be shown on plans whenever practicable. If this cannot readily be done, the points where construction joints will not be allowed should be indicated. Often times the design is of such nature that a construction joint in a certain location will greatly impair the strength of the structure and it is this condition that must be guarded against in the drafting room, since the construction foreman has no intimate knowledge of the method of design used, and is therefore guided more by the daily output of his plant than by considerations of design, in the location of construction joints.

Many unsatisfactory pieces of work are to be found which are laid to the construction methods, when in reality the designer is at fault in his presumptions as to the capability of the man in charge in interpreting just what he (the designer) had in mind. It is not good engineering to spend days or perhaps weeks designing and detailing a structure; very carefully indicating every bar, the thicknesses of the various sections of concrete and then to omit entirely all notes or data regarding the vital points in its construction as governed by the design. By making plans more complete much of the trouble now experienced in various kinds of concrete work will be practically eliminated.

TEST OF SOO TERMINAL, FLAT SLAB CONSTRUCTION, CHICAGO.

The reinforced concrete flat slab structure of unusual area which is to serve as a freight terminal for the M., St. P. & S. Ste. M. Ry. at Chicago, has recently been tested to ascertain the stresses under heavy loads.

The reinforced concrete slab, 18 inches thick, supported on columns with large flaring heads spaced 24 feet centers, will carry tracks and teamways, while the space below will be used for storage. The tests and measurements were made over four panels with a total load of over 200 tons per panel. The test load was applied by means of eight steel ore cars 25 feet long (21 feet 6 inches center to center of trucks) on four tracks, loaded with crushed stone so as to produce a load of 205,000 pounds on the wheels, this concentration being in excess of the designing load, Cooper's E-50. The test tracks were laid on stone ballast at 12 feet centers. After this test in which necessary stress and deflection readings were taken the load was removed and recovery measurements taken. After this was done the tracks were shifted half a panel and the test repeated. A test with ten cars on a single track midway between columns was also made. Extensometers and micrometer strain gages were used to ascertain the stresses produced. The computing of results of the test will require some time.

CURRENT PRICES—CONCRETE MATERIALS.

Portland Cement—The tendency in the market is upward and prices about 5c above those for last month except in the west. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general 40 cents per barrel (4 sacks) is refunded on return in good condition. Prices per barrel (including 4 cloth sacks) are as follows: Boston, $1.72; New York, $1.58; Chicago, $1.55; Pittsburgh, $1.50; New Orleans, $1.64 on dock; Memphis, $1.82; Cleveland, $1.65; Detroit, $1.60; Indianapolis, $1.60; Peoria, $1.73; St. Louis, $1.55; Milwaukee, $1.55; Minneapolis & St. Paul, $1.65; Montreal, $1.75 to $1.80; Toronto, $1.90; Winnipeg, $2.40 to $2.50; Kansas City, $1.63; Omaha, $1.78; Portland, Ore., $2.20; Spokane, $2.40; Seattle, $2.30; Tacoma, $2.30.

Crushed Stone—1½ in. stone, prices per cubic yard, f. o. b. cars in carload lots, unless otherwise specified. Boston, 80c per ton at the quarry; New York, 90c to $1.00, in full cargo lots at the docks; Chicago, $1.15; Toronto, 75c per ton at quarries; Spokane, $1.25; Seattle, $1.25; Portland, Ore., $1.00.

Gravel—Prices given are per cubic yard f. o. b. cars in carload lots unless otherwise noted. Boston, 75c; New York, 95c to $1.00; in full cargo lots at docks; Chicago, $1.15; Portland, Ore., $1.00; Spokane, $1.25; Seattle, 75c; Winnipeg, $1.85; Tacoma, 75c.

Sand—Prices are per cubic yard, f. o. b. cars in carload lots unless otherwise indicated. New York, 50c, full cargo lots at docks; Chicago, $1.25; Toronto, $1.15; Portland, Ore., $1.00; Spokane, $1.25; Seattle, 75c; Winnipeg, $1.75; Tacoma, 75c.

Reinforcing Bars—The demand is increasing and prices in general are about 5c per hundred lbs. above those given last month. Pittsburgh base quotations on mill shipments f. o. b. cars, are $1.25 per cwt., with the prevailing extras on bars under ¾-inch or base. The following are quotations on base bars per 100 lbs. for mill shipments from other points, f. o. b. cars: Chicago, $1.43; Portland, Ore., $2.25; Spokane, $2.60; Seattle. $1.95; Tacoma, $1.95.

Shipments from stock are being made at the following prices per cwt. f. o. b. cars: Pittsburgh, $1.75; New York, $2.15; Chicago, $1.80; Montreal, $2.15; Toronto, $2.25; Winnipeg, $2.50; Portland, Ore., $2.65; Spokane, $2.70; Tacoma, $2.15; Seattle, $2.15.

Metal Clips for Supporting Bars—$8.00 per 1,000.

For the majority of the prices given we are indebted to the Universal Cement Co., Concrete Steel Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., of Seattle, Portland, Spokane and Tacoma.

ODE TO A CONCRETE MIXER.

O thing of unnumbered gyrations,
O creature the acme of grace,
With pebbles and sand as thy rations,
Thus stuffing thy innocent face.

Living the life of a rover,
Thoughtfully chewing your cud,
Turning it over and over,
And dropping it out in the mud.

Stop! Let us broaden our knowledge,
By watching its innocent tricks;
Applying its lesson to life's college,
And learning to gracefully mix.

Chain Belt.

Through Arch Bridges of Reinforced Concrete*

Descriptions and Data Regarding Arches of This Unusual Type Built in Europe and America.

By A. M. Wolf, C. E.

Introduction.

A great number and variety of concrete arch bridges have been built within the last decade, but the number of through arches built has been exceedingly small. In America such structures are very rare and unusual, but in Europe especially in Germany, structures of this type have reached a comparatively high state of development. The longest span through arch in America is that of a highway bridge at Fitchburg, Mass., with a clear span of 193 feet 7 inches, while in Europe there are two of still longer span, viz., 196 feet 10 inches, at La Mescla, in France, and one over the Saar River near Völklingen, both designed for railway traffic. The accompanying table from Beton u. Eisen, 1914, No. 2, gives data comparative data regarding structures built in Europe and America in one comprehensive article which shall be of service to the American engineer in the development of the through concrete arch bridge for railway and highway traffic.

General Design.

Referring again to the table it will be seen that these arches are designed for the most part either as fixed spans or three-hinged arches, while occasionally horizontal ties are used to take the thrust of the arch ribs and thus relieve the abutments of thrust and allow the use of small abutments. In this latter case the arch ribs are usually fixed at one end and allowed to move

ARCH BRIDGES WITH SUSPENDED FLOORS HAVING SPANS OF OVER 40 METERS (131 FT 2¾ IN)

No.	Structure	Date	Clear Span	Total Width Roadway	Type of Rib Construction	Contractor	Reference
1	Railroad Bridge over the Rhone at Chippis, Switzerland.	1909	193'6 7/8"	28'2 5/8"	Fixed Span	Frote Westermann & Co. Zurich.	Handb. fur Eisenbetonbau Vol. 6, 2nd. Ed. Page 646.
2	Highway Bridge at Kaltenthal, Bavaria.	1909	137'9 1/2"	26'3"	Fixed Span	Rank Bros, Munich.	Handb. fur Eisenbetonbau Vol. 6, 2nd Ed. Page 654.
3	Railroad Bridge at La Mescla, France.	1909	196'10"	13'9 3/8"	Fixed Span with Tension Member in middle part.	M. Danat, Nizza.	Beton u. Eisen 1913. No. 7. Page 154.
4	Highway Bridge over the Ems-Weser Canal at Niedernholz.	1909	154'10 1/4"	24'3 1/4"	Three Hinged Ribs	Aktien-Gesellschaft für Beton-u-Monier Bau. Berlin.	Handb. fur Eisenbetonbau. Vol. 6 2nd. Ed. P. 656. Beton u Eisen 1913. No. 6. P. 126
5	Highway Bridge over the Oder-Spree Canal at Biegenbrück.	1910	145'	19'8 1/4"	Three Hinged Ribs	-do-	Armierter Beton 1912 No. 3. Page 91.
6	Railroad Bridge over the Werra River at Heringen, Thüringen.	1910	173'10 5/8"	18'8 7/16"	Fixed Span	Christiani & Nielsen Hamburg.	Beton u. Eisen 1911 No. 8. Page 173.
7	Highway Bridge over the Ems-Weser Canal at Stöcken, Engelbostel.	1910	151'7"	36'1"	Three Hinged Ribs	Windschild & Langelott Dresden	
8	Highway Bridge over the Ache, at Marquartstein, Bavaria.	1911	164'0 1/2"	22'1 3/4"	Three Hinged Ribs	Wayss & Freytag A.-G., Neustadt a.d.H.	Mörsch der Eisenbetonbau 3rd. Ed. Page 568.
9	Highway Bridge at Waldbruck, Tyrol.	1912	154'2 7/16"	19'4 1/4"	Tension Member. Iron Roller and Rocker Bearings.	-do-	-do- Page 571.
10	Highway Bridge at Fitchburg, Mass.	1912	193'6 7/8"	40'	Fixed Span Melan System	Mc. Harg-Barton New York	Beton u. Eisen 1913. No. 7. P. 151 (Engr. Rec. Vol. 67 Page 4.)
11	Highway Bridge at Mestre, Italy.	1912	132'2 5/8"	33'1 5/8"	Tension Member. Spring Hinge and Iron Roller Nest Bearing	Giuseppe Pasquali Mestre, Italy.	Beton u. Eisen 1914 No. 2. Page 25.
12	Railroad Bridge over the Saar at Völklingen.	1913	196'10"	-	Fixed Span	Wayss & Freytag A.-G., Neustadt a.d.H.	

Note:- The term with Tension Member as applied to Type of Rib Construction refers to a Horizontal Tie to take up the thrust of the arch ribs.

Table 1. Long Span Through Arches of Reinforced Concrete.

regarding reinforced concrete arch bridges with suspended floors, having spans of over 40 meters or 131 feet 2¾ inches.

From this table it can be seen that America is far behind Europe in the construction of bridges of this type, having only one arch with a span of over 40 meters (131 feet 2¾ inches), as against eleven in Europe. The number of smaller span bridges of this type in Europe is much greater than in America. From this it would seem that there is a sort of hesitancy on the part of American engineers to use this type of arch.

It should be noted that the longest of these structures are designed for railroad traffic with spans of nearly 200 feet, while in America the longest span deck arch bridge for railroad traffic will be the Tunkhannock viaduct, now under construction, with arches of 180 feet clear span. We have no through arches designed for railroad traffic, this type being limited to use in highway bridges, for the time being at least. There is no reason why they should not be used for railroad bridges in America, except that there is a general apathy of engineers towards using new types of structures. They have been used for overhead highway bridges over railroad tracks and this seems to be the field in which they will be most popular for some time to come.

The purpose of this article is to present details of design and

*Copyright, 1914, W. E. Magraw.

freely at the other by means of some sort of roller or rocker bearing. This type is exemplified by the bridge at Mestre, Italy, described herein. In such a structure the stresses due to temperature need not be taken into consideration, as they have little effect on the structure.

Structures with horizontal ties are the usual type for relatively short span highway bridges. They possess the advantage of lighter abutments which is a considerable item where space is limited or where foundation conditions are unsatisfactory for abutments to resist thrust. In America three-hinged structures are not used, fixed spans with and without tension members being used almost entirely.

Through arch bridges are especially adapted to low crossings where an ordinary arch with deck roadway would cut down the river prism, or the headroom over streets or tracks too much, unless the road grades were raised considerable. Where such conditions prevail and the spans are comparatively short, beam or girder bridges of either the deck or through type can be used, but when the spans are over 40 feet they become uneconomical and the only type of reinforced concrete construction which can be used economically is the through arch. By their use one gains the advantage of the long span concrete construction possible only with arches and the comparatively thin floor system found in short

span beam and girder bridges. For low stream crossings where no piers are desired in midstream and for overhead highway crossings over several railroad tracks with limited headroom they are the ideal type of reinforced concrete construction, affecting a considerable saving over any other type, mainly on account of the relatively light weight construction required.

The floor system is usually of beam and slab construction with stringers longitudinally between transverse floor-beams, the ends of which are attached to steel or reinforced concrete suspenders anchored into the arch ribs. The hangers are usually encased in concrete to add stiffness.

For spans up to about 100 feet the ribs can be made stiff enough to resist lateral pressure due to wind without being tied together, this allows the use of ribs with comparatively small rise. For longer spans with consequent greater rise it is the general practice to tie the two arch ribs together with stiff struts at the middle portion near crown to give the structure more lateral stiffness. These struts should be carried as far from the crown in both directions as the clearance required over the deck will permit.

In the design of the arch ribs for through arch bridges the same general methods of calculation as are used for deck arch bridges can be applied, the exact points of application of loads being given by the location of hangers, thus simplifying the calculations somewhat. The arch ribs are in general of parabolic shape, proportioned in accordance with the usual methods of computation by the elastic or static theory. The reinforcement should be designed and detailed as for eccentrically loaded columns, with considerable transverse reinforcement in the form of stirrups or hoops.

On account of their exposed condition, the arch ribs and floor systems are subjected to greater temperature changes than ordinary concrete arches, and where fixed end arches are used, special attention should be paid to stresses in ribs and floor due to temperature, otherwise the results are sure to be unsatisfactory.

Two types of floor systems are used, viz., transverse beam and slab; and the transverse floor-beam, longitudinal stringer and slab type. The floor beams are in any case designed as simple beams, the stringers as continuous and also the floor slabs. The hangers should frame directly into the floor beams and be designed to carry the floor loads and in addition be able to resist wind and other lateral stresses.

The following illustrated descriptions of European and American structures for railway and highway traffic should prove of more than passing interest to railway bridge engineers.

European Structures.

Reinforced Concrete Through Arch Bridge for Railway Traffic Over the Werra River at Heringen, Germany.

The Werra River bridge (Figs. 1 and 2) on the Gerstungen-Wacha Railway line, near Heringen, in Thuringia, is composed of two fixed end, parabolic arch ribs of reinforced concrete, 14 feet 5 inches apart, with clear spans of 173 feet 11 inches, carrying a floor system suspended below the arch ribs.

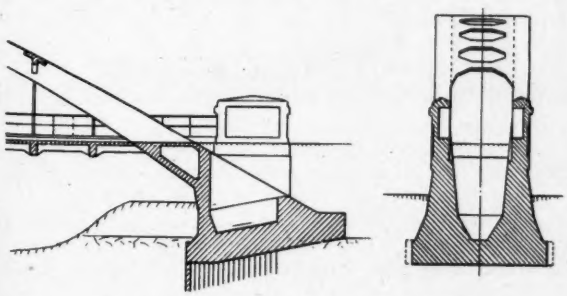


Fig. 1. Part Longitudinal and Transverse Section, Werra River Bridge.

This type of structure was decided upon because a certain clearance above highwater mark was required and no other type could be used for the span in question without raising the track grade. The rigid arch was used on account of the easier construction involved and the greater stiffness in all directions which such a structure possesses in spite of the more difficult computations required in design.

In order to do away with troubles due to variation in temperature, the roadway suspended from the arch ribs by steel hangers was divided into three sections. The end sections are fixed to the arch ribs and the middle section is rendered independent by sliding expansion joints at the inner ends of the end sections. Steel hangers were used for the reason that the movement of the roadway due to temperature changes would cause abnormal bending stresses and cracks in reinforced concrete hangers.

The arch ribs of varying depth from crown to springing are of reinforced concrete, thoroughly braced at the top of the middle half of bridge above the clearance lines by reinforced concrete struts of T-section, securely anchored and filleted to the ribs. The arch ribs, 3 feet 7 inches wide, are 5 feet 3 inches deep at the crown, 8 feet 2 inches deep at spring and have a rise of 34 feet. (See Fig. 1.)

Through Arch over Selle River at Pettoncourt, France, (Fig. 12).

The arch abutments were formed by widening out the arch ribs below the deck and connecting them at the river side and bottom with reinforced concrete slabs.

The arch ribs are many centered, so laid out as to have the line of dead load pressure follow the center line of ribs. The maximum bending movements and normal forces due to the live load for the several sections were computed by means of influence lines. A temperature variation of $\pm 40°$ F. was used in design.

The loadings used were a locomotive weighing 34 tons, followed by freight cars with 16-ton concentrations on three axles, 10 feet 6 inch centers. The ribs and floor system were designed for the condition of loading producing the maximum stresses.

The unit stresses allowed in design were: 500 pounds per square inch for concrete in compression without considering temperature stresses, and 650 pounds considering temperature stresses; concrete in tension, including temperature stresses, 275 pounds square inch; steel in tension, 14,000 pounds per square inch. The calculated maximum stresses in the concrete are very close to the allowable, while the stress in steel is only about 6,700 pounds per square inch for the maximum condition, and the tension in concrete 196 pounds per square inch.

The roadway consists of transverse floor beams of reinforced concrete 13 feet 7 inches centers, suspended from steel hangers anchored into the arch ribs. These beams are heavily reinforced with bent and straight bars, and stirrups. At the middle the beams are 2 feet 7 inches wide, while at the ends, beyond supports, they are only 1 foot 7½ inches wide. Four lines of longitudinal stringers carrying the 5½-inch deck slab, are framed into the floor beams. The outer stringers are set back from the ends of floor beams and are also raised above the top of deck slab to

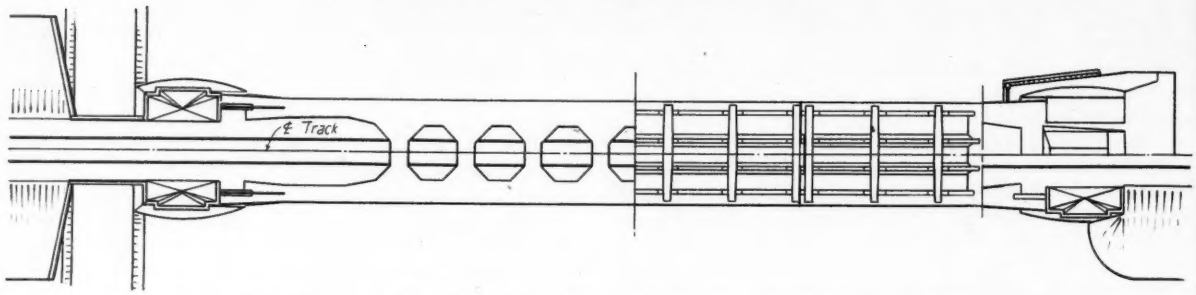


Fig. 2. Part Plan of Arch Ribs and Floor System, Werra River Bridge, Heringen, Germany.

act as a curb. The intermediate stringers are of considerably larger section and more heavily reinforced. All stringers except those in end panels of the floor sections are designed and reinforced as continuous beams. The ends of all stringers have reinforced haunches to care for the compression due to continuity, the extra section being required since the stringers were designed as T-beams. The floor slab is reinforced for continuous action over the stringers and is sloped toward the middle for drainage.

Double floor beams are used at the points where expansion joints occur in the floor. Figure 2 shows the floor construction.

The arches were concreted before the floor system, but the forms for floor system were removed before those of the ribs, so as to avoid undue stresses in the hangers, for had the reverse order been followed the hangers would have been placed in compression by the settlement of ribs, which amounted to 7/16 inch, while 1⅜ inch was provided for.

Provincial Overhead Highway Bridge at Mestre, Italy.

The new provincial highway bridge over the state railway from Treviso to Mestre, on the highway from Mestre to Mirano, Italy, is a most interesting structure. The details and data given herein are taken from the January 20th, 1914, issue of Beton u. Eisen.

The bridge consists of a main span composed of two through arch ribs, 31 feet 2 inch centers, with suspended floor over the railroad tracks, and approach decks of reinforced concrete on framed trestle bents of the same material. The arch has a clear span of 132 feet 2⅝ inches, and an overall width of roadway of 33 feet 1⅝ inches. The thrust of the arch ribs is taken up by tension members at the level of the floor system. One end of the arch is fixed and the other has a movable rocker bearing, so that the abutments are subjected to vertical load only. This design of main span was used on account of the expansion and contraction which is sure to take place in the structure and because the foundation condition were not the best to be desired.

The clear space between arch ribs is 27 feet 10⅝ inches, of which about 23 feet are taken up by roadway and 2 feet 5½ inches on each side by walks. (See Figs. 3 and 4.) The arch ribs are of I-section, 5 feet 10⅞ inches deep and 3 feet 3⅜ inches wide, with a web 11¾ inches thick, reinforced as shown in Fig. 5. The middle portion of the ribs are braced against wind stresses by transverse struts of reinforced concrete.

The hangers are spaced 8 feet 10¼ inches apart and support the cross beams, carrying the floor slab. Between the floor beams are stringers spaced 3 feet 11¼ inches centers. The outer stringers lie in the plane of the arch ribs and they are combined with the horizontal tension members between ends of ribs. These tension chords are reinforced with fifty-six 13/16 inch dia. bars in six rows, tied together with horizontal and vertical stirrups. The ends of bars are securely anchored by passing them through plates and placing a nut on the threaded ends. The fixed end of the ribs is built as a spring hinge, while the movable end is supported by a roller nest bearing, similar to that used in steel bridges.

The following conditions of loading were used in the design:

1. A crowd of people weighing 335 pounds per square foot.

2. A double axle wagon with an axle load of 8 tons and six horses of ¾ tons each, hitched in pairs. The axles 9 feet 10 inch centers, width 8 feet 2 inches, and loaded length 52 feet 6 inches.

3. An electric railway car with double axle cars, 26 feet long, with axle loads of 8 tons, axles 8 feet 2 inch centers, followed by trailers of 6 tons axle loads. For the axle loads an impact of 125 per cent was allowed.

4. The wind loads considered were: 168 pounds per square foot for dead load only acting and 100 pounds per square foot for live load acting.

The arch ribs were designed as two hinged with horizontal tie; two conditions of loading were considered.

1. Entire bridge loaded for greatest thrust.

2. One-half of bridge loaded, to ascertain the greatest moments. Temperature stresses need not be taken into consideration for the system of supports used.

This structure represents the latest European practice in the design of through arches, having been completed in 1912.

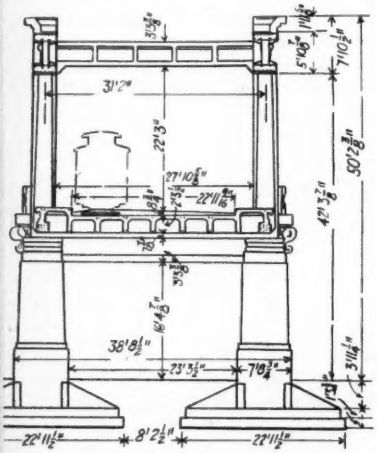


Fig. 4. Cross Section, Mestre Arch.

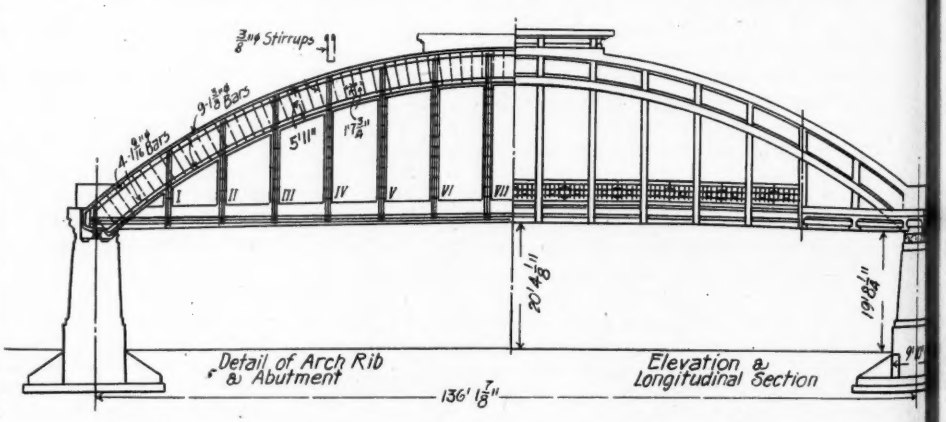


Fig. 3. Through Overhead Highway Arch at Mestre, Italy.

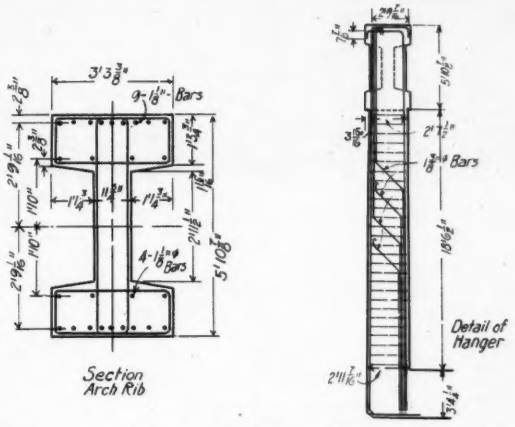


Fig. 5. Details of Arch Rib and Hanger, Highway Bridge at Mestre, Italy.

Three-Hinged Through Arch Bridge Over the Ems-Weser Canal—Niedernholz, Germany.

The highway arch over the Ems-Weser Canal at Niedernholz is a three-hinged arch with suspended floor. The parabolic arch ribs, with a center to center span of 157 feet 1⅞ inch, are two in number, spaced 22 feet 7½ inches centers. They are 2 feet 7½ inches wide and 3 feet 3⅜ inches deep at the crown, with an increasing depth toward the spring.

The theoretical rise of ribs is 26 feet 3¾ inches. The reinforcement consists of twenty ⅞-inch dia. bars near both extrados and intrados tied with stirrups and hoops 1 foot 8 inches centers. The ribs are tied together and braced laterally against wind pressure by three transverse struts of reinforced concrete. (See Fig. 6.) The struts are spaced 17 feet 3 inches centers, with the middle one at the crown and each of the other two directly over a floor hanger. The reinforcement for these struts consist of twelve ½-inch dia. bars, anchored into the arch ribs and tied with ¼-inch stirrups.

The reinforced concrete floor hangers at either side carry longitudinal girders, reinforced for fully continuous action, which in turn support the floor beams. The hangers, spaced 11 feet 5¾ inches centers, are quite heavily reinforced and securely anchored into the arch ribs. The floor beams are spaced about 5 feet 9 inch centers and support a deck slab, reinforced as continuous over the beams. The floorbeams with a clear span between longitudinal girders of 21 feet are reinforced with straight and bent bars ⅞-inch dia., as shown in Fig. 6. Beams occurring at hangers are anchored to same by bent bars extending well up into the hangers. Near the ends of bridge the deck dips down, following the line of arch ribs. The distance of 20 feet between ribs is divided into a roadway 14 feet 5 inches wide and two narrow walks, one at either side.

The abutments are of heavy mass concrete unreinforced except directly under hinges, where considerable reinforcement is placed in several layers to transmit the loads.

This arch differs from the others described in that no horizontal tension members are used to connect the ends of ribs and relieve the abutments of horizontal thrust. The three hinged type was selected since, for compressible foundations considerable settlement of abutments may take place without injuring the arch. The use of three hinges practically does away with temperature stresses and since the arch is statically determinate, higher unit stresses may be used.

The details shown are taken from the Beton Kalender for 1911.

Highway Bridge Over the Oppa River at Troppau, Austrian Silesia.

The through arch bridge over the Oppa River at Troppau is an interesting example of a highway bridge of this type with horizontal tension members to take up the thrust of the arch ribs and thereby relieve the abutments of thrust. This design was made necessary on account of the lack of space for abutments large enough to resist the horizontal thrust; as built they receive only a perpendicular load.

The arch ribs, 20 feet 4 inches centers, have a clear span of 130 feet and a theoretical rise of 19 feet, or about 1/7 of the span. (See Fig. 7.) The ribs are 2 feet 2 inches wide, 3 feet 3 inches deep at the crown and 4 feet deep at the spring. They are braced and tied together by three transverse struts, 1 foot 8 inches deep and 10 inches wide, spaced 24 feet 6 inches on centers, the middle one being placed at the crown of the arch. The ribs are reinforced with heavy, plain, round bars, symmetrically placed near intrados and extrados, as shown in the cross-section of bridge, Fig. 8. Around these main bars are 11/16-inch dia. hoops, spaced about 1 foot centers, to tie the entire reinforcement together.

To take up the horizontal thrust of about 440,000 pounds, horizontal tension members, 2 feet 6 inches deep by 1 foot 4 inches wide, connect the ends of arch ribs. The main reinforcement of these tension members consists of six steel bands, 0.8 inch by 9 inches wide, arranged in two rows. These bands are anchored back beyond the intersection with the arch ribs by being riveted to an anchor block of short vertical channels riveted to three horizontal I-beams, the middle one acting as a spacer for the bands. The details of this connection and the detail of reinforcement at intersection with arch ribe are shown in Fig. 9. The bands were considered more economical on account of easier connections than were round rods with any type of positive anchor or tie.

To care for rather excessive stresses due to temperature, longitudinal movement of the bridge was provided for in the design of abutments. They were built up with reinforced concrete bearing blocks composed of 1 part cement, 1 part sand and 1 part basalt chips, the points of bearing being covered with lead plates. The abutments are of different detail, as shown in Fig. 9, one hav-

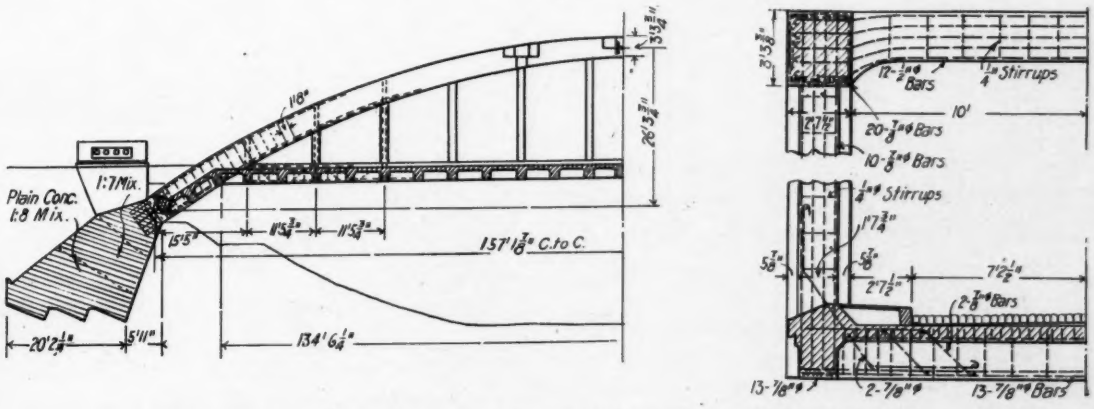


Fig. 6. Three-Hinged Highway Arch Over Ems-Weser Canal, Niedernholz, Germany.

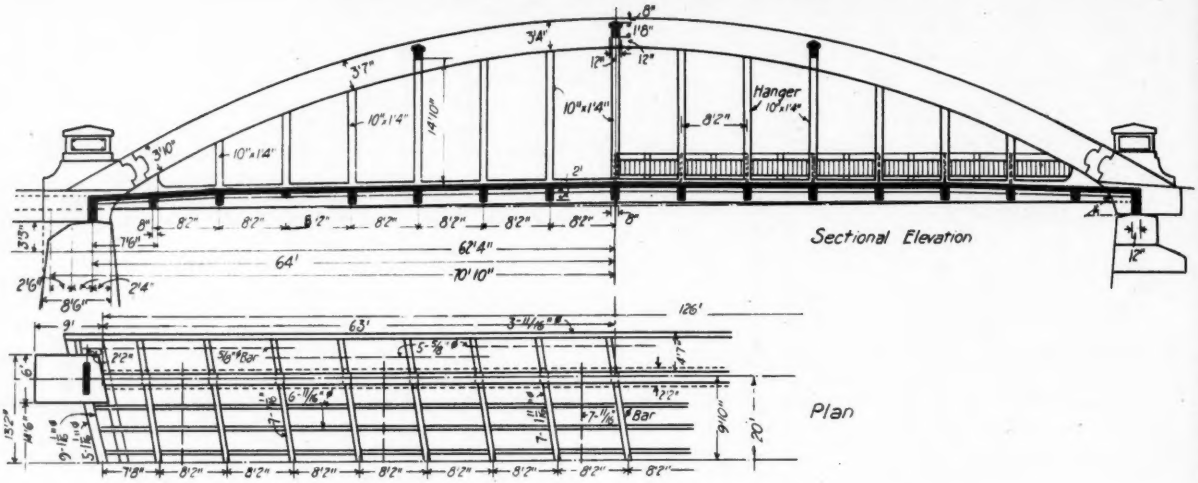


Fig. 7. Oppa River Bridge at Troppau, Austrian Silesia.

ing a double beveled rocker surface bearing, while the other has a single straight sliding point.

The hangers from ribs to support the floor system are 10 inches by 1 foot 4 inches in cross-section, reinforced with four 1 1/16-inch dia. bars, tied together with 9/16-inch hoops, 12-inches on centers and securely anchored into the arch ribs and the horizontal tie below.

The floor system consists of floor beams 10 inches wide and 1 foot 8 inches deep under deck slab, spaced 8 feet 2 inches centers directly under the hangers. These beams are reinforced with bent and straight bars, some being bent to provide reinforcement for the cantilever beams supporting the sidewalk, which projects 4 feet beyond the outside face of the arch ribs, making the overall width of bridge 28 feet 6 inches. Between these floor beams are longitudinal stringer beams 8 inches wide and 8 inches deep under slab, spaced about 2 feet 8 inches centers. The deck slab, about 6 inches thick, is reinforced with bent rods perpendicular to the stringers. The sidewalk slab is reinforced parallel to the cantilever floor beams which carry a longitudinal stringer at their outer edge. As will be noted on the plan, the bridge is set on a slight skew.

The cost of this structure, exclusive of foundations and paving, was about $8500.00. The details shown are taken, in part, from "Reinforced Concrete Bridges," by Frederick Rings, an English work; as are the details for the Lübben bridge.

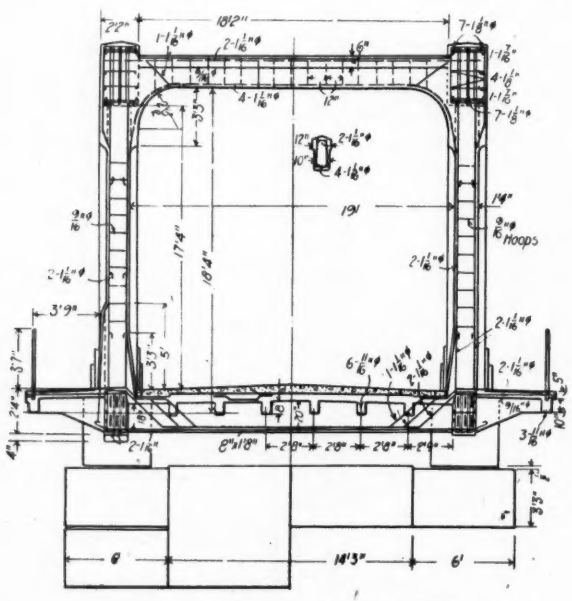


Fig. 8. Cross Section, Oppa River Bridge.

Spree River Bridge at Lübben, Prussia.

A through highway arch bridge was used over the River Spree at Lübben on account of the limited amount of depth allowable for the floor system, viz., 3 feet. Such a condition made the use of deck arch or beam construction impractical. This bridge, of a slightly different type, was designed so as to be fixed at one end and hinged at the other, thus allowing for movement caused by temperature stresses. To relieve the abutments of thrust, horizontal tension members connect the ends of ribs.

The bridge proper has an overall length of 102 feet and a width of 30 feet 10 inches, made up of a 19 foot 8 inch roadway and cantilever sidewalk, projecting 3 feet 8 inches beyond the outside face of arch ribs. The total depth at the crown is 14 feet 9 inches. (See Fig. 10.)

The arch ribs, 2 feet square in section at the crown, and 2 feet 9 inches deep at the spring are parabolic in form, with a clear span of 82 feet, and a theoretical rise of about 15 feet. The reinforcement consists of fifteen 1-inch dia. bars near both extrados and intrados and two at the outside between these layers. These bars are tied together with ½-inch dia. hoops, spaced at short intervals. At the ends of ribs some of the reinforcing bars are bent into the tension members, while at the fixed end some are also bent down into the abutment. Diagonal ties are also used to connect the ribs and tension members. See Fig. 11.

The members resisting the horizontal thrust are 2 feet 2 inches by 2 feet, reinforced with twenty-six 1⅛-inch bars, arranged in four rows, and anchored to steel plates at the ends beyond the

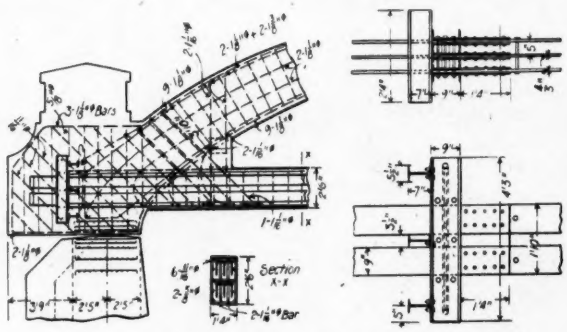


Fig. 9. Details of Arch Rib and Tension Chord Connection, Oppa River Bridge.

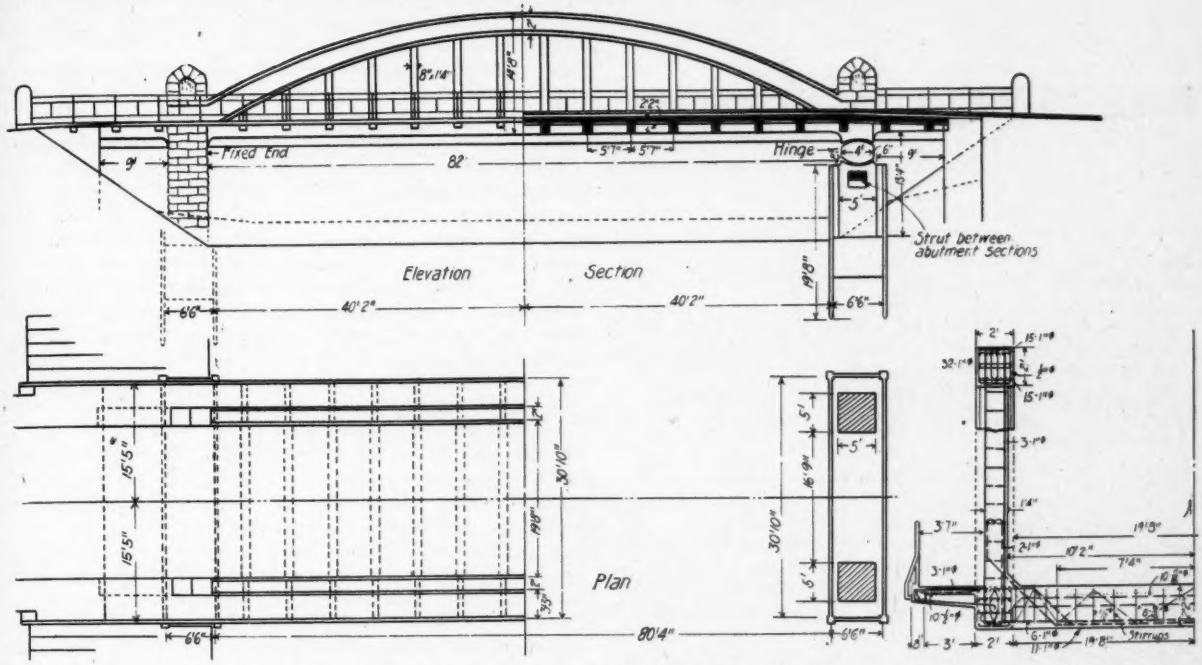


Fig. 10. Spree River Bridge, Lubben, Prussia.

intersection with the ribs by means of thread and nut connections. This detail, which provides a very positive anchor, is shown in Fig. 11.

The suspenders from arch ribs to tension members below take the end reactions of the floor beams and are spaced 5 feet 7 inches centers. The hangers are 8 inches by 1 foot 4 inches, the longer ones being reinforced with six 1-inch dia. bars, tied together with hoops. These bars are securely anchored into the arch ribs and bent at the bottom so as to loop around the bottom reinforcement in the tension members, besides this some of the bars from the floor beams are bent up and anchored in the hangers. The short hangers are reinforced with four 1-inch dia. bars.

The cross-beams spaced 5 feet 7 inches centers were calculated as tee-beams with continuous flanges 7 inches thick composing the floor slab. The beams are 1 foot 7 inches deep under the slab with a web thickness of 1 foot. At the connection with the floor slab are 6-inch fillets. The reinforcement consists of eleven 1-inch dia. bars, some bent and some straight, and ½-inch dia. stirrups arranged as shown in Fig. 11. These floor beams are continued out beyond the tension members with a reduced cross-section to carry the sidewalk slab 3 inches thick. They are 8 inches wide and of varying depth, being 9 inches deep at the edge of walk and 12 inches deep at the connection with the horizontal ties. At the outside edge they are connected by a fascia beam.

At the ends of bridge the roadway cantilevers out for a distance of 9 feet beyond the abutments, the horizontal tension members being extended and reinforced to act as cantilever girders. The remainder of the floor construction is similar to that used on the rest of the bridge.

The cost of this bridge was $7785.60.

Seille River Bridge at Pettoncourt, France.

The through highway arch over the Seille River at Pettoncourt, France, shown in Fig. 12 is quite typical of the smaller European structures of this type.

The parabolic arch ribs are of reinforced concrete with fixed ends, having a comparatively small rise. The ends of ribs are connected with horizontal tension members a few feet above the springing line of arch ribs at the roadway level, to relieve the abutments of horizontal thrust. The roadway beams supporting the deck slab are carried by vertical suspenders anchored into the arch ribs. The abutments are of the U-type, built of plain concrete.

The illustration shows very clearly how well through arches are adapted to low crossings, involving spans too long to be economical for girder bridges. The structure presents a pleasing

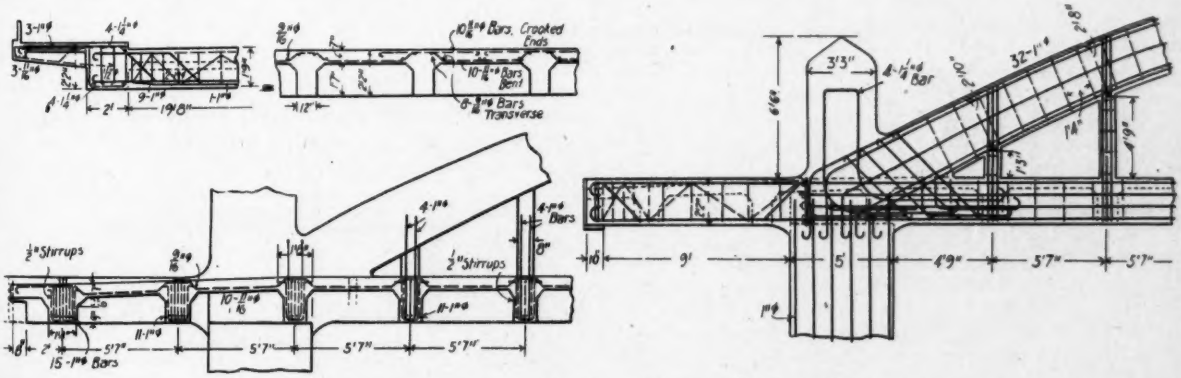


Fig. 11. Details of Floor System and Arch Rib Reinforcement, Spree River Bridge, Lubben, Prussia.

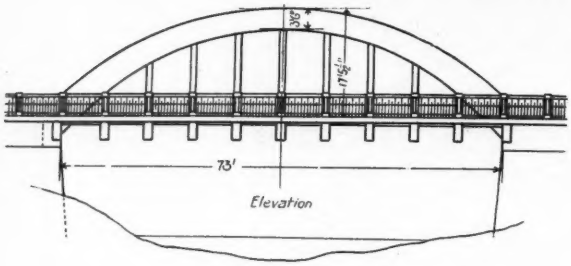


Fig. 13. Benson St. Arch Bridge at Reading, O.

appearance on account of its slender and graceful outlines. Such a bridge would be in harmony with most any surroundings where a comparatively narrow crossing is to be made.

This bridge was built by Ed. Züblin & Co., of Strassburg, Germany, in 1904. The writer is indebted to the above firm for the illustration of the work.

American Structures.

Fifth Street Viaduct, Fitchburg, Mass.

The reinforced concrete arch viaduct carrying Fifth street, Fitchburg, Mass., over the N. Y. C. & H. R. R., the B. & M. R. R. and the Nashau River, is of special interest because one of the end spans, over the railroad tracks, is the longest through arch span in America.

The bridge has an overall length of about 650 feet, a width of 40 feet and is composed of a through arch of 204 feet 9 inch center to center span, three 113-foot deck arch spans, one deck span of 76 feet 3 inches and one of 32 feet 7½ inches.

Because of the small clearance between the grade line on the bridge and the railroad tracks passing underneath at one end, the deck spans used in the remainder of the structure could not be used. After considerable study a through arch span, with fixed ends and suspended floor, was decided upon. The arch ribs spaced 26 feet 8 inches centers, are parabolic with a clear span of 193 feet 7 inches, and a theoretical rise of 48 feet, reinforced with riveted steel ribs. The steel ribs are made up of two lattice girders, 1 foot 7½ inches apart, latticed together top and bottom with angles. The flanges of these ribs consist of two angles riveted to a vertical plate, the two flanges being tied together with angle lacing. The ribs are 3 feet 6 inches deep at the crown and 7 feet 10 inches at the spring. A concrete casing 30 inches wide and 6 inches deeper than the steel work encases and protects the same.

The steel ribs take bearing on and are riveted to, structural steel pedestals with horizontal bases anchored to the concrete abutment and pier. At the crown and haunches, 39 feet each way from the crown, the ribs are braced and tied together by pairs of transverse lattice girders, encased in concrete.

The floor system consists of a reinforced concrete slab 5 inches thick, carried on transverse floor beams, suspended from the arch ribs by means of 10-inch, 25-pound I-beams encased in concrete and spaced about 5 feet 3 inches centers. These hangers, with webs perpendicular to center line, are riveted to transverse diaphragms in the arch ribs and to plates on the floor beams, thus giving a very positive connection. The floor beams are latticed girders of varying moment of inertia with a cantilever at either end to carry the sidewalks, which are 6 feet wide. The beams are encased in concrete, which is assumed to take a part of the compressive stresses. A continuous reinforced concrete fascia girder connects the ends of floor beams directly under the suspenders.

The roadway, with a grade of 3.5 feet per 100 feet, intersects the center lines of arch ribs about 76 feet each side of the crown and beyond these points the floor is carried on deck spandrels. The handrail at the edge of sidewalks is of reinforced concrete consisting of premolded posts and panels.

The through arch span was designed for a dead floor load of 17,600 pounds per panel, a live load of 200 pounds per square foot of roadway, 150 pounds per square foot of walk and a concentrated load of 25 tons on an area 6 feet by 10 feet. All structural steel conformed to the A. R. E. A. specifications for material and workmanship and to Theodore Cooper's specifications for steel highway bridges. Concrete of a 1:3:5 mix was used in foundations; 1:2½:4½, in piers, abutments and spandrels above foundations, and 1:2¼:4, in arch ribs, floor beams and slabs.

This structure was designed by Mr. James H. Fuertes, consulting engineer, New York.

It is of interest to note in this connection that European structures of this magnitude are built without the use of structural steel, concrete reinforced with small bars being used in all cases cited. This again shows the conservative spirit of the American engineer.

Benson Street Highway Bridge at Reading, Ohio.

The Benson street bridge over Mill Creek, connecting the villages of Reading and Lockland, Ohio, about eight miles north of Cincinnati, is said to be the first through arch built in America. The arch ribs, 34 feet centers, have a clear span of 73 feet and a rise of 14 feet above the suspended roadway. The ends of ribs are connected by horizontal ties at the floor level, thus relieving the abutments of any thrust. The total width of bridge is 50 feet, made up of two 9 feet 6 inch walks and a 31 foot roadway. (See Figs. 13 and 14.)

The through type of arch was used in order to preserve the required waterway without raising the street grade, after it was found by comparative bids to be $2,400.00 cheaper than a steel girder bridge, the cost of the concrete structure being $8,600.00.

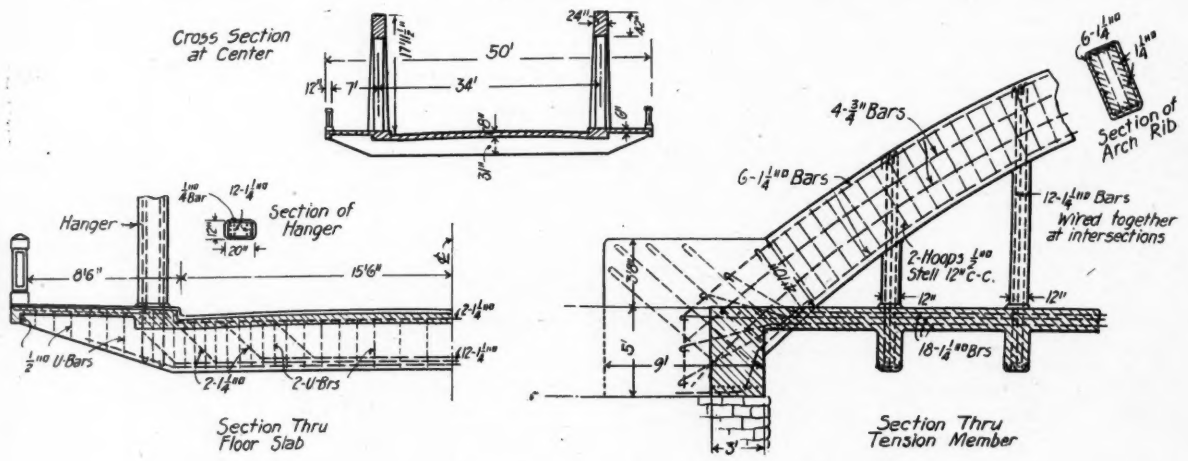


Fig. 14. Details of Benson St. Arch, Reading, O.

The old abutments, being in good condition and capable of carrying the vertical load, caused the designers to use the tied arch with heavy transverse girders between ends of arch ribs to transfer the load uniformly over the old abutments on which they rest, no special provision being made for movement due to temperature changes. The arch ribs are designed to care for temperature stresses and no cracks have developed in the ribs.

The arch ribs have a width of 2 feet at the crown and 3 feet at the spring, with a depth varying uniformly from 3 feet 6 inches at the crown to 4 feet 10 inches at the springing line. The main reinforcement consists of six 1¼-inch square bars near extrados and intrados, bound with ½-inch hoops, as shown in the details, Fig. 14. The hangers carrying the floor beams are 12 by 20 inches in section, reinforced with twelve 1¼-inch square vertical bars, securely looped around arch rib and floor beam bars. These hangers act as wind bracing and care for the column action in the ribs due to eccentricity.

The arch rib ties are formed by thickening the floor slab under the line of arch ribs and reinforcing this portion with eighteen 1¼-inch bars in three rows to take the tension caused by the horizontal thrust. The ends of bars are fanned out as shown in Fig. 14, and looped around the outer bars in the arch ribs for anchorage. With this design a horizontal shear in the arch ribs at the haunches equal to the horizontal thrust must be taken care of, which is not the case when the abutments take the thrust.

The floor slab, 8 inches thick, is reinforced as a continuous slab over the several reinforced concrete floor beams, which are 16 inches wide, 31 inches under slab at center line of bridge, and spaced 7 feet 5 inches centers. The sidewalk slab is carried on cantilever beams of varying section, which are continuations of the main floor beams. The handrail is of ornamental iron between concrete posts.

The unit stresses used in design were 16,000 pounds per square inch in steel and 600 pounds per square inch for concrete in compression, for a designing live load due to two 40-ton street cars and a uniform live load over the remainder of the bridge.

The bridge floor was concreted first, then the hangers up to the under side of line of arch ribs and lastly the arch ribs. By this method a considerable saving in falsework was made, and a more monolithic and waterproof structure was obtained.

It is worthy of note that cold twisted square bars were used entirely for the reinforcement and no structural steel whatever was used. This is different from the usual American practice of using structural shapes for the main members and in this respect resembles very closely the European practice.

Arch Bridge at Lockland, Ohio.

Another through arch bridge recently built (1913) between the towns of Lockland and Reading, Ohio, of design similar to that just described is shown in Fig. 15.

This structure is nearly 200 feet long with a 25-foot roadway and two 5-foot sidewalks cantilevered out beyond the arch ribs. The details of design and construction are the same as for the 73-foot span bridge just described. The old abutments were used for the new bridge, since they take no thrust.

This type was chosen for this latest structure since past experience in this locality has shown that the through concrete arch is cheaper, of better appearance and more satisfactory in every way than a steel bridge.

Kinsman Road Bridge, Cleveland, Ohio, Cleveland Short Line R. R.

The Kinsman Road bridge, Cleveland, Ohio, is an overhead highway bridge over the Cleveland Short Line R. R. This through arch with a skew span of 100 feet, a width of 66 feet 6 inches, and ribs 5 feet square at the crown, reinforced with steel angle frames, was described and illustrated in the January, 1913, issue of *Railway Engineering*. The floor slab of reinforced concrete is carried on steel beams suspended from the arch ribs by eye-bars. The arch is designed so that the entire thrust from the ribs is taken by the abutments.

A through arch was used in this location, over six railroad tracks on account of the limited headroom available.

Little Cottonwood River Bridge, Blue Earth County, Minnesota.

A highway arch of rather unique design is the Little Cottonwood River bridge, in Blue Earth County, Minnesota. This structure is of what might be called a half-through arch and is commercially known as the Marsh "Rainbow" Arch, the general design being patented by Mr. J. B. Marsh.

The structure illustrated in Fig. 16, 100 feet long with a 16-foot roadway, has a span of 60 feet, the rise of the arch ribs being 15 feet. The thrust of the arch ribs is taken directly by the abutments, no horizontal tension members being used to take up this thrust. The roadway is suspended from the arch ribs at a level about half way between crown and springing. The arch ribs are 1 foot 6 inches wide and 1 foot 6 inches deep at the crown, the width remaining constant and the depth increasing toward the springing. The reinforcing consists of a latticed angle box frame consisting of four angles laced four ways. At points where hangers occur plates are riveted to the rib angles and the four-angle hangers riveted to them. This makes a very positive and satisfactory connection, the angles taking all the tensile stresses.

From these hangers are suspended floor beams reinforced with angles and bars. The two end floor beams are connected to and cast integral with the arch ribs with an expansion joint provided between the floor slab and these beams, so that the floor can slide over them freely when expansion and contraction occurs without overstressing the arch rings. Fig. 16 shows the general features of this type of construction.

The handrail is a concrete cast integral with the rest of the bridge. This rail is rather simple, but they can be made more ornamental if desired. The cost of a 60-foot clear span bridge with 16-foot roadway will vary from $2,500 to $3,500, depending on the locality and the foundation conditions.

Concrete bridges generally have a tendency to injure themselves, due to changes in temperature, and this type of bridge is designed to eliminate this difficulty. The floor slab slides freely over both the end floor beam and the abutment on which the end of the slab rests. This allows the arch ribs to rise and

Fig. 15. Through Arch Bridge at Lockland, O.

fall, and the floor system to expand or contract due to temperature changes, without any bad results.

Bridges of this type designed and built by the Marsh Engineering Co., Des Moines, Iowa, to whom the writer is indebted for illustrations and data, are ordinarily designed for a live load of 200 pounds per square foot live load and a temperature range of 80 degrees. For these conditions the stresses are very low. Single spans up to 120 feet have been designed, but long bridges can be designed by the use of piers. No designs have been made for structures carrying railroads, but there seems to be no reason why they should not be used in short span bridges. For overhead highway bridges this would be an ideal and economical type.

Several of these bridges have been built in Yellowstone Park after the army engineers had investigated them very thoroughly.

It should be noted that these arches differ from the usual designs in that the floor system lies at a level about half way between crown and spring and that no provision is made to take up the thrust of the arches by ties through the floor slab. The

Fig. 16. Through Arch, Rainbow Type, Over Little Cottonwood River, Blue Earth County, Minn.

Marsh patent contains a number of points that are new in concrete bridge design and which are the result of the long experience of Mr. J. B. Marsh in concrete bridge design and construction.

The "rainbow arch" possesses the permanency as can only be obtained in concrete and at the same time gives the same waterway as a steel bridge and at a cost about the same as for a steel bridge with concrete floor.

Fig. 17 illustrates another highway bridge of this type with a relatively short span.

Conclusions.

Based on the facts given, it can be said that the through arch of reinforced concrete opens up a new and very promising field. It is especially adapted to overhead highway and even railway bridges of moderate spans. The great amount of track elevation and depression work now being carried on throughout the country should hasten the adoption of the through arch as a standard construction.

The advantages summed up briefly are:

1. Light weight as compared to other types of reinforced concrete structures.

2. The relatively thin floor construction required makes them especially adapted to low crossings where headroom is an important feature. If the grade has to be raised to give the necessary clearance, then the cost of the work will be unduly increased.

3. By providing rocker or sliding bearings for the ribs and by using horizontal ties to take the rib thrust, the effects of temperature changes on the structure are rendered practically nil.

4. The use of horizontal ties to take up the rib thrust allows the use of much smaller abutments, since only vertical load is transmitted to them.

5. On long bridges expansion points can be provided at certain intervals, to relieve the floors of undue temperature stresses.

6. Experience has shown this type to be as cheap or cheaper than steel bridges with concrete floors, fulfilling the same requirements of the local conditions. When the maintenance of a steel bridge is considered the concrete structure which is practically permanent, is by far the cheaper.

7. The through arch carefully proportioned with parabolic arch ribs possesses an appearance far more pleasing than a beam and girder or a steel bridge of any type.

The use of the I-section of reinforced concrete for the arch ribs, as exemplified by the overhead highway bridge at Mestre, Italy, shows the general tendency toward decrease of dead weight, and it is safe to say that this section will be used more frequently in the future. In fact there is more or less discussion going on at the present time among American engineers as to its efficiency in deck arch design.

The main disadvantage and perhaps the one which has limited the use of the through arch in this country is the difficulty of obtaining satisfactory connections between suspenders or hangers carrying the floor and the arch ribs. This difficulty is entirely eliminated by the use of structural steel ribs and suspenders with riveted connections. This, however, increases the cost of the structure considerable. By referring to, and following European practice, in which reinforced concrete hangers are used almost exclusively, this objection will no doubt disappear. Reinforced concrete hangers should be reinforced in such a manner as to allow them to take lateral stresses due to wind, floods, etc., and stresses due to temperature changes (in a longitudinal direction) besides the vertical load due to the floor.

Fig. 17. Typical Rainbow Arch for Highway Traffic.

On account of the much heavier railway loadings used in America as compared with those used in Europe, it is hardly safe to say that any railroad bridges approaching the spans of the larger European structures (200 feet) will ever be used in America, and even if they are, their economy will be doubtful. For relatively short spans, say up to 125 feet, there is no reason why satisfactory and economical designs for railroad bridges cannot be made. The development of reinforced concrete in America has been so rapid that, based on past performances, the through reinforced concrete arch for railway traffic is practically a certainty, and its general appearance is only a matter of time.

On completion of the new Duluth plant of the Universal Portland Cement Co., the total yearly capacity of this company will be increased to 13,400,000 barrels. Two buildings are practically finished and foundations for others are being poured at the rate of 100 cubic yards per day.

The Signal Department

THE CHARACTERISTICS OF A GRAVITY CELL.*

By B. W. Meisel.

The gravity cell is a two-fluid, reversible cell of the Daniel type. The electrolyte consists of zinc and copper sulphates, in solution, and when both solutions are placed in the same vessel the zinc sulphate will rise to the upper section of the jar and the copper sulphate will take a position in the lower section. The reason for this is the difference in the specific gravity of the two solutions, and it is due to this phenomena that the cell receives its name, "gravity cell." The electrodes consist of copper and zinc, and when these two elements are placed in the solution of their respective sulphates, a chemical combination is set up and an electric current may be produced by connecting the electrodes together by means of a piece of wire.

The action which takes place within the cell when connected as described above is purely a chemical one, and may be expressed by the chemical equation, $Cu\ SO_4 + Zn = Zn\ SO_4 + Cu$, or in other words, zinc goes into solution, forming more zinc sulphate, and copper comes out of solution, forming metallic copper.

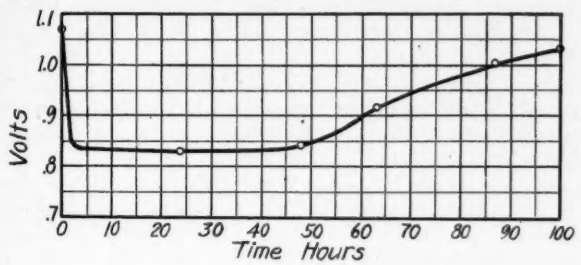


Figure 1.

It is on account of this difference in the solution pressures of the two metals that an electric current is produced, when the electrodes are connected together, the theory of which may be explained as follows: Assuming that all elements, under normal conditions, are equally charged with both positive and negative electricity, also that metallic ions are positive. When a zinc ion or particle goes into solution it carries with it a positive charge, leaving an equal negative charge behind. Also when a copper ion goes out of solution it carries with it a positive charge, leaving an equal negative charge which neutralizes with the zinc ion positive charge. The positive charge from the copper ion is then neutralized with the negative charge on the zinc electrode by means of the wire connection between the two electrodes, making a complete cycle. This chemical reaction continues until all of the copper sulphate or zinc is used up.

Several electrical tests were made on a gravity cell working under different conditions. The results of the tests were plotted and a number of characteristic curves of a very interesting nature were obtained.

The first test was made on a cell immediately after it was set up. Voltage readings were taken and the results were as follows:

	Volts.
When cell was set up	1.068
After cell had been on short circuit for 24 hours	0.83

For the next 76 hours the cell was connected to a four ohm relay and voltage readings taken as follows:

	Volts.
48th hour after cell was set up	0.842
63d hour after cell was set up	0.915
87th hour after cell was set up	1.0
100th hour after cell was set up	1.03

The above results were plotted with volts as ordinates and time as abscissas. The curve is shown in Fig. 1.

Test of a Gravity Cell at Different Temperatures.

The next test was made for the purpose of determining the characteristics of a gravity cell at different temperatures. The cell was first packed in ice and a circuit connected to it as shown in Fig. 2. After the cell had reached its lowest temperature, voltage and current readings were taken for the various circuits through which the current flowed. Similar readings were taken for other temperatures as the cell became warmer, due to the adding of hot water to the vessel containing the cell. The following readings were recorded: Temperature (T) in degrees centigrade; Voltage of cell (Vo.) with switch "S" open; Voltage of cell (Vc) with switch "S" closed to contact "A" and delivering current, (I) of 0.15, 0.2 and 0.25 amperes through a variable resistance "R"; Voltage of cell (E) with switch "S" closed to contact "B" delivering current to relay of four ohms resistance and current (I') delivered to same relay.

The intermial resistance of the cell for the different temperatures recorded was calculated from the results obtained by means of the formula. Internal resistance $(Ri) = \frac{Vo.-Ve.}{I}$

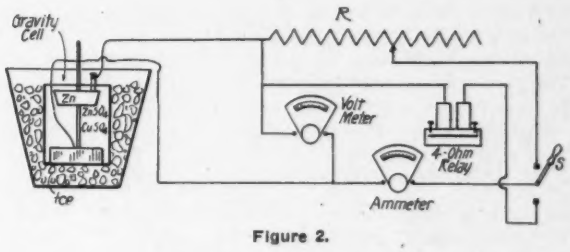


Figure 2.

DATA FOR FIGURES 3, 4, 5, 6, 7 and 8.

T.	Vo.	Vc.	I.	Vo-Ve.	Ri = Vo.-Ve. / I.	I' Relay.	E. Relay
		.568	.15	.498	3.325		
3°C.	1.066	.405	.2	.661	3.305	.141	.6
		.248	.25	.818	3.275		
		.67	.15	.396	2.64		
7°C.	1.066	.545	.2	.521	2.605	.155	.65
		.41	.25	.656	2.625		
		.68	.15	.386	2.57		
10°C.	1.066	.55	.2	.516	2.58	.157	.66
		.43	.25	.636	2.545		
		.73	.15	.336	2.24		
16°C.	1.066	.61	.2	.456	2.28	.164	.698
		.51	.25	.556	2.224		
		.748	.15	.318	2.12		
20°C.	1.066	.64	.2	.426	2.13	.168	.715
		.535	.25	.531	2.124		
		.765	.15	.301	2.007		
25°C.	1.066	.67	.2	.396	1.98	.170	.73
		.576	.25	.49	1.96		
		.787	.15	.279	1.86		
30°C.	1.066	.695	.2	.371	1.855	.174	.745
		.61	.25	.456	1.824		

* Copyright, 1914, W. E. Magraw.

		.82	.15	.246	1.64		
35°C.	1.066	.74	.2	.326	1.63	.18	.772
		.655	.25	.411	1.644		
		.84	.15	.226	1.501		
40°C.	1.066	.764	.2	.302	1.501	.184	.788
		.685	.25	.381	1.524		

From the above results a curve was plotted, using (Ri) as ordinates and (T) as abscissas. This curve is shown at "B" Fig. 4. (Ri) remained practically constant at the same temperature for different values of current, as can be seen from the data.

By using the internal resistance curve "B," Fig. 4, for one cell, the internal resistance curves "A" for two cells in series, Fig. 3 and curve "C" for two cells in parallel, Fig. 5 were calculated. Two cells in series would, of course, have twice the internal resistance of one cell, and two cells in parallel one-half the resistance of one cell. Now from these resistance curves "A," "B," and "C" voltage, current, temperature curves were plotted, using the volts as ordinates and amperes as abscissas with a given temperature for each curve. These curves are shown in Figs. 3, 4, and 5, together with their resistance curves, "A," "B," and "C."

These voltage, current, temperature curves were plotted from their respective resistance curves by taking the resistance (Ri) of the cell from the curve at any temperature, and since (Ri) is constant for any value of current, (I) at a given temperature, thereby assuming a given value of current (I), the voltage (V) can be figured from the formula (V) = (Ri)I, and we may plot the point V, I. The curve will pass through O, O, since if (I) be be taken as zero, (V) becomes zero, and the curve will follow a straight line since (Ri) is constant for any value of (I) at a given temperature or, in other words, $\frac{(Ri)}{(I)}$ equals (V) the slope given temperature or, in other words, — — equals (V), the slope of the line, which is the tangent of the angle made by the line and the abscissa. Since the tangent remains constant, the plotted curve is a straight line.

Another set of voltage, current, temperature curves may be drawn to represent the external resistance. These curves will start from the point (Eo), where (Eo) is the open circuit voltage and the current (I) equals zero, since R, the external resistance, on open circuit is infinity, or $I = \frac{Eo}{\infty} = o$.

(Eo) from the data equals 1.066 volts for one cell. Another point for any given temperature curve can be taken from the data under (Vc) for ordinates and the corresponding (I) for abscissa.

These curves may also be drawn through points of the previously drawn voltage current, temperature curve, at the corresponding temperature, where the ordinates equal $\frac{1}{2}$ Eo or .533

These points, where the lines cross one another, represent points of equal internal and external resistance and the output is a maximum according to the formula for power output, $P = \frac{Vc^2}{R+Ri}$

If (P) is to be a maximum, R+Ri=O, or R=Ri (not considering algebraic signs), therefore, the maximum power output occurs when the voltage equals .533.

In a manner similar to that explained above, voltage, current, temperature curves for two cells in parallel and two cells in series were drawn. The open circuit voltage for two cells in parallel would be 1.066 volts and for two cells in series it would be 2.132 volts.

These curves may be put to a practical use. For instance, if the voltage reading across a track circuit, and the temperature and arrangement of cells known, then by referring to these curves, the value of the current could be found.

Suppose the voltage reading was .5 volts for one cell at 10°C. or 50°F.; looking at the curve for 10°C. at the point where the ordinate is .5, the abscissa is found to be .227, which is the value of the current at that voltage with one cell. The external resistance can now be found from the equation $R = \frac{V}{I}$ or R=2.2 ohms. The total power generated Pi may be determined from the

Useful power P=VI=.5×.227=.1135 watts.

Watts lost=.244—.1135=.1305 watts.

Efficiency=$\frac{.1135}{.244}$=.465, or 46.5%.

(The development of other characteristic curves and interesting information will appear in a succeeding issue.)

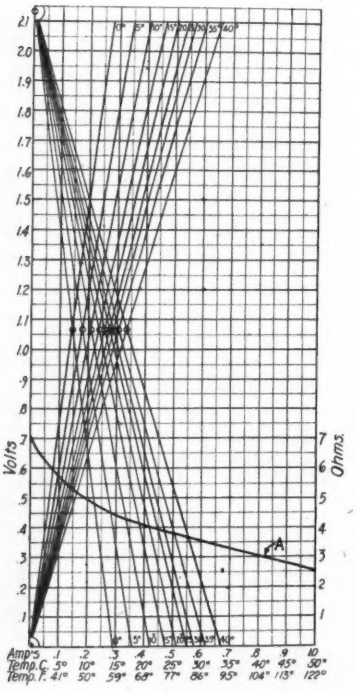


Figure 3.

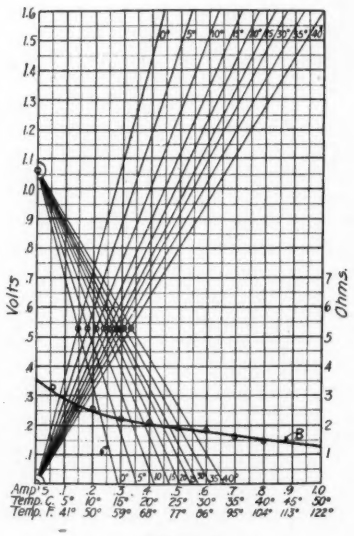


Figure 4.

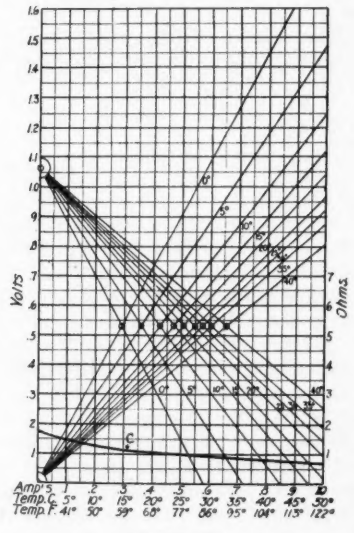


Figure 5.

The Maintenance of Way Department

Causes and Prevention of Rail Creeping

A CORRESPONDENT in India has requested information from the practical track men who are readers of *Railway Engineering*, on the causes for rail creeping and corrective measures which may be applied.

Considerable information has been published on this subject, and it has been noted in practically all cases that rail creep is most severe on track over soft bogs, or on track with a springy bottom. It is very evident, therefore, that the give or deflection under trains is one of the most important causes of rail creeping.

The effect of gravity is also shown in the fact that creeping is usually most severe on descending grades. This is frequently noted in a long sag between hills, where the track runs toward the sag, showing movement on the descending grade, with very tight, kinky track in the sag, and track with sufficient expansion and which does not run on the ascending grade.

The effect of the direction of traffic is also shown in the above typical instance; the movement of the rails in double track is opposite, and in the direction of traffic in either case.

The fact that creeping is in the direction of traffic has long been recognized. The additional effect of the application of brakes on heavy descending grades, is probably not so well realized. Where the grades are steepest, it is frequently necessary in the operation of fast trains to set the brakes on the down grade, which sets up a dragging action in addition to the action of the train if running free.

Since rail creeping is most marked on a soft bottom, obviously the tendency is decreased if the solidity of the bottom can be increased, whether this is accomplished by natural settling, by improved or greater depth of ballast, by natural drying up of the supporting earth, or by the effect of artificial drainage.

Drainage, then, is an important feature to consider, in decreasing the tendency toward rail creeping. However, this remedy many times cannot be applied at all, or is too expensive, and, it is, of course, not effective when the creeping is entirely due to direction of traffic, braking trains, and gravity.

The subject of rail creeping is a live and interesting one and we wish to obtain the experiences and opinions of a large number of maintenance of way men on this subject.

The following is a suggested outline for articles describing rail creeping and its remedy:

General Track Conditions.
- Single or double track.
- Size, type and length of rail.
- Size, kind and number of ties per rail.
- Kind, quality and depth of ballast.
- Class and amount of traffic.
- Type of locomotives.
- Grade per cent (down or up).
- Depth of cut or height of fill.
- Conditions of subgrade.
- Character of surrounding country.
- Severity and extent of trouble.

Special precautionary measures (inspection, etc.), necessary to insure safety of traffic.

Remedies.
- New ballast.
- Drainage.
- Were anti-creepers used?
- Type and make.
- How many were necessary per rail length?

Other remedies.

Final results obtained.

When anti-creepers are used, it is apparent that the number should be varied to meet the severity of the conditions. When there is a combination of soft bottom with track on a curve at the foot of a steep descending grade the conditions are most severe, as in such cases the dragging tendency of intense application of air brakes is added.

Some railways have experimented with track which is not anchored by the angle bars at the joint ties. The necessity for anti-creepers is well recognized in such case. Description of results attained with this method will be especially interesting and acceptable.

We will pay space rates for articles on the above subject, namely: "Causes and Prevention of Rail Creeping," or on allied subjects. Use diagrams, if necessary, to illustrate the methods or devices used.

Address letters to Editor *Railway Engineering*, 431 S. Dearborn St., Chicago, Ill.

PROTECTIVE PAINTS.

In a paper read before the Technical Society of the Pacific Coast, D. F. Leary, speaking of Protective Paints and Pigments, asserts that lead, preferably white lead, is peculiarly possessed of all the necessary paint qualities in a superlative degree. Opacity or covering quality is also present to a greater degree than in a paint with any other kind of a base. Experiments show that with the exception of lead, all bases so far used have a greater affinity for water than for linseed oil, but white lead and linseed oil will unite in water to the exclusion of the latter. White lead and linseed oil are given preference for priming, even for concrete surfaces, the statement being made that this is so elastic that it can scarcely be divorced from the surface though subjected to violent distortion.

Zinc oxide, the only near competitor of white lead, is not so easy of application, dries slower, and peels soon, and lacks the durability of lead.

Repainting is easier over a white lead paint, because with other paint that has cracked, the original cracks appear after repainting, practical observation having proven this.

White lead and linseed oil are their own void fillers, and have a stronger grip on metal than any other paint.

Red lead, while not quite as good a primer as white lead, is given the preference over all substitutes for lead, and is an excellent primer. It has to be used in excess on vertical surfaces, however, and its action is more rapid and violent which is likely to cause it to be lacking in oil and elasticity.

If only one coat is to be applied, red lead gives a better protection than any other pigment, as it makes a heavier coating and dries quicker.

Amorphous (powdered) pigments pack closer than crystals, the leads being classed under the former. The combination between lead and linseed oil is a chemical one, while combinations with crystalline bases are mechanical only.

Mr. Leary sums up the properties of lead as follows: forms the best working and flowing paint; has the most durable and elastic film; is linseed oil's affinity; repels water; the most durable oil dryer, yielding a varnish quality.

HANDLING AND REMOVING SNOW.

By J. W. Powers, Supervisor of Track.

Many of the roads in the Northern States and in Canada are obliged to contend with snow in large quantities and keeping the track clear constitutes a large item of expense. In order that your readers may become familiar with the amount of snow with which we have to contend in this vicinity, I give you below a reproduction of an article from one of our local dailies which was printed a few years ago:

"In 1867 the Rome & Watertown Road was blocked for eleven consecutive days. The late D. G. Eggleston, a passenger conductor, started from Oswego one Thursday morning and never reached this city until a week from the following Monday. In February, 1875, the Cape Vincent branch was blocked for two weeks and not a train passed over it. The branch was only opened when it had been shoveled out by hand for its entire length. There is comparatively little shoveling now. The huge, slow, irresistible rotary snow plow has superseded the shoveler and can do in hours what he used to do in days. The rotary is a slow-moving creature, but for its own purposes excels the old-time snow shoveler as a street sweeping machine excels a feather duster. It is pushed into a snow drift, chews it up and spits out the snow in a stream that returns to earth thirty feet or more from the rack. It is a sort of utilitarian combination of the working principles of the Car of Juggernaut and a sausage machine. It doesn't do to get too near a rotary. A farmer at Furniss wanted to see the machine at work and climbed a tree about twenty feet from the track. The stream of snow from the rotary struck the old man, carried him far from the tree "and left him with just the top of his head protruding from the snow. The railroad men dug him out of the snow and his pastor lectured him for using improper language."

While this article may be slightly exaggerated, it creates in the mind a just conception of the absolute necessity of modern snow equipment in this vicinity in order to successfully combat the elements.

Snow must be contended with in many forms, the most common difficulties being encountered on account of drifted snow, of which we receive our share as our tracks are located along the shores of Lake Ontario and are exposed to the lake winds. The record for the winter of 1911-12 shows that 152 inches of snow fell in this vicinity. It stormed for 36 consecutive days, the wind sometimes reaching a velocity of 50 miles per hour. This was an unsually severe winter, spreading hardship and danger all around but particularly for railroad men. Everyone knows that during such storms railway operation is fraught with great danger and that each employee is required to use more than ordinary care in the performance of his duties so that the possibility of accidents may be reduced to a minimum. There are but few who understand the hardships endured by the track men whose duties are exceedingly arduous during such severe weather, and it requires men of strong physical constitution as well as of a high moral character and splendid readiness to perform the responsible work required of them. Yet they are ever ready to do their part and to take their place cheerfully to keep their track in a safe and passable condition which needs constant attention to permit the safe movement of traffic. How well each department performs its duties is proven by the splendid record made, for during the above mentioned storm not a single accident or derailment occurred.

It is imperative that every department of railway service be in shape to successfully battle with the elements. As the handling of snow belongs to the supervisor or roadmaster, he should make all necessary preparations and see that all tools and snow equipment is in first-class condition. A sufficient quantity of snow shovels, picks, brooms and salt should be kept on hand. Signs should be put up to protect crossings, frogs, switches or any other obstruction where it is necessary, so that the man operating the plow will know where to raise the flangers or take in the wings. All cuts where trouble is experienced by snow drifting into same and blocking the track, should be protected by either permanent or portable snow fence or by the planting of trees. The efficiency of a snow fence depends upon its durability and height and the distance it is placed from the track. If the fence is of ordinary height it should be set up about 75 ft. from the nearest rail. The distance from the track should be about 10 ft. for every foot in height. The fence should be run parallel with the track for the full length of the cut. A wing should be turned on each end of it, approaching the track gradually until the end of each wing extends a distance of 50 ft. beyond the end of the cut and about 30 or 40 ft. from the track. This wing protects the track from the wind that blows parallel to the track or from a quarterly direction. In some cases it is necessary to build 2 lines of snow fence to protect deep cuts. Portable snow fence should be set up before winter sets in and the ground freezes, so that it can be properly staked. It should be taken down as soon as the necessity for its use is over, and the broken panels repaired and carefully piled, and protected from fire by digging a trench around where they are piled. The panels should be wired together to prevent them from being blown on to the track during high wind storms.

In some cases it is more economical to widen a cut by steam shovel than it is to build and maintain a snow fence. Even if the cost of widening a cut so that it will hold no snow is greater than maintaining a snow fence the former is preferable on account of the benefit the track derives from it.

Before the ground is frozen, some of the ballast should be removed from under switch points, guard rails, and spring frogs,

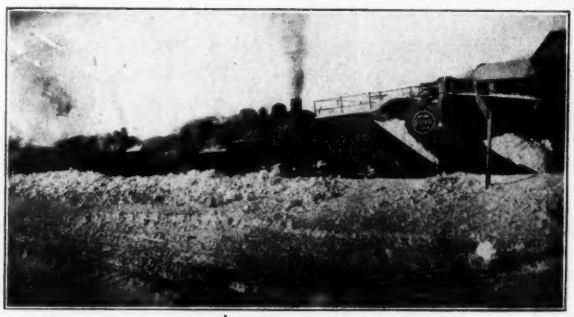


Figure 1.

so that snow and ice can easily be removed, and to allow switch points and movable rail of spring rail frogs to move freely. Provision also should be made for proper drainage at such points so that in case of a thaw, water will not remain between ties from which ballast has been removed. All crossings should be put in good repair and defective or loose plank or plank projecting above the top of rails should receive prompt attention. Also flange rails should be installed in all important crossings.

When a reduction of forces is made in the fall the majority of the men will remain in the boarding cars, if they know you will give them preference in case extra men are needed. This enables the supervisor to increase his forces rapidly in case of emergency or severe storm. Foremen should be required to canvass the territory along their sections so that all available men can be secured as soon as possible provided they are needed. A sufficient number of reliable men should be employed to operate plows day and night if necessary. In addition to the man who operates the flanges and wings, another man should be placed where he can watch the flanges to see that they work properly, as it frequently happens that wet snow will form ice and prevent flanges from raising and the same is true if flanges become bent. The man who is operating the plow is unable to see whether the flange raises or not, therefore there should be a man located where he can watch them and signal the engineer to stop if the flanges do not work properly, as they are liable to do serious damage to switch points and other obstructions.

Particular attention should be given to switches and interlocking apparatus during snow storms as these are the points where

trouble is first experienced. A sufficient number of men to keep them in serviceable condition should be detailed during the day and night. Steam, hydrocarbon and other snow melting devices have been found very effective especially where good drainage is provided. The judicious use of salt in frogs and switches and highway crossings, especially if flange rails are used, will keep them in good condition until they can be cleaned. It should be used sparingly as it corrodes switch plates and other connections.

The modern snow plows have proven very satisfactory in this vicinity. We use both single and double track wing elevators equipped with air flangers. Figure No. 1 shows snow plow outfit waiting for block.

It is of vital importance that the foreman send snow reports to the supervisor or roadmaster promptly. Such reports should be sent by telegraph when necessary and each foreman should advise the number of extra men employed so that the supervisor could decrease or increase his forces as the occasion requires. The supervisor should also keep in touch with the chief dispatchers as they are advised by train crews and trainmasters of the existing conditions. No time should be lost in ordering crews to handle snow equipment when the use of such equipment is

Fig. 2. Clearing Snow from Yard Tracks.

considered necessary, and if storm increases, tonnage should be cut down if necessary. It is often advisable to side track all freight trains as this is more economical and satisfactory than to take chances of getting them stalled and thereby tieing up the road. The engines of trains which may be ordered on sidings on account of the severity of storms could be utilized to handle snow fighting equipment. During severe storms snow equipment should be kept in constant service. If snow in cuts becomes so deep that the wing plows are unable to throw the snow from cuts, the rotary should be put in service and the road kept open. When snow plows are in operation on main tracks, one member of the train crew should be in the plow to act as lookout and to communicate signals to the engineer. One extra copy of train order should be given to the lookout and he should communicate same to plowman.

The best power available should be used in snow plow service. Two engines should be used when necessary and enginemen should have full pressure of steam before attempting to move through deep cuts or heavy snow drifts. The engineer and plowman should know that full pressure of air is maintained at all times in order that flangers and brakes may be properly operated. Before leaving a plow or flange car at any point, the brake wings and flangers should be operated a number of times to ascertain if they are in good working order.

It is sometimes impossible to go through a cut on the first run. The plowman, however, should keep the wings out and the flangers down until train stops. He should then raise flangers and close wings. The engineer can reverse his engine and back out as there is a good flange behind him. An examination, however, should be made before starting ahead to ascertain if the wheels are on the rail as there is a possibility of the wheels being derailed while backing through the snow. It is sometimes necessary to shovel the snow from the nose of the plow in order to clear it and so that it may be able to throw the snow a sufficient distance from the track. The engine or engines handling a snow plow outfit should take their full capacity of fuel and water at every point reached where same is obtainable, as the liability of unforeseen delays and mishaps makes it imperative that no risks be taken of running short of fuel or water. The water supply, however, can be readily replenished by shoveling snow into the tank. During an unsually severe storm it is often advisable to take a car of coal with the outfit.

If a train becomes stalled, prompt action should be taken to release it. The most economical and efficient method of doing so will depend upon various conditions as the same conditions are hardly ever encountered, consequently methods of procedure are various also. In order to decide on the proper methods, experience is necessary. To obtain the greatest benefit every effort must be well directed or a great deal of time and energy will be wasted. It is sometimes possible to hire men locally and by so doing the train is released much more rapidly than by starting a relief train with plow to release stalled train, as in many cases it will take several hours to reach it. If it is impossible to hire

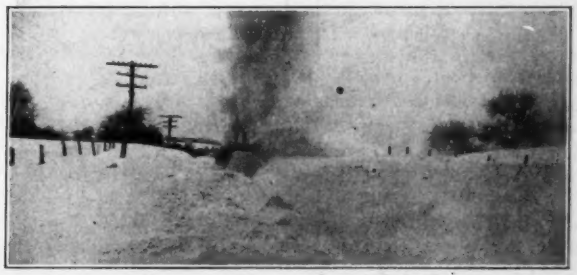


Fig. 3. Rotary In Action on Main Track.

men locally, the snow plow or rotary with a sufficient force of men should be despatched as soon as possible to release stalled train. If there is much snow between the station and where the train is stalled, it is advisable to use two engines headed in opposite directions as it is dangerous to back up from stalled train during a severe snow storm, and there is a liability of a derailment to the engine backing up or to the caboose or coach, but if two engines are used headed in opposite directions as stated above, this danger is eliminated. The car in which men are riding should never be placed between these engines, for in bucking snow it is liable to break in two and cause serious injury to the men. The plow should be run as close as possible to the stalled train and the men unloaded, after which the plow should be backed up and cut out at the nearest siding. Then the engine or two as the case may be should come back to the stalled train. By this time the men should have several of the cars ready to be pulled out and they should be uncoupled and pulled back as far as the rail is cleaned, after which the track can be flanged out and the same procedure repeated until the entire train is released. Care should be taken not to endeavor to pull too many cars at once as they are liable to become derailed or the drawheads are liable to pull out. If the stalled train is a passenger train, it is extremely unwise to uncouple the engine unless there are sufficient men on hand to release them promptly, as the steam pipes freeze quickly when cars are uncoupled in such weather. Also unless cars can be quickly coupled they soon become uncomfortable for passengers.

It frequently happens that snow falls and drifts to a depth of several feet in our yard tracks during one night. It is a hard matter to secure men outside of our regular forces to work in severe storms and if labor could be had to remove snow, it is a slow and expensive method. The quickest and cheapest way to remove snow from yards is by the use of the rotary plows,

flangers and levelers such as are used for leveling dirt. Figure No. 2 shows such an outfit in operation.

While our rotary is equipped with flangers, they are seldom used as it is impossible to see ahead and operate them with safety while the rotary is in motion, as the snow obstructs the view. This is why the flange car is used. The train is run on one track, the rotary throwing the snow to one side, sometimes throwing it over five or six tracks. The leveler pushes the snow clear of the track next to the one on which the train is operated. When the end of the track is reached, the train is backed down and the next track is taken and this operation continues until the entire yard is cleared from snow. It is better to use the first

Fig. 4. Condition of Cut After Rotary Has Passed.

track cleared to back up on, as the hood or front of the plow pulls snow on the track, thus by using the same track it is only necessary to flange one track the second time. In clearing snow from tracks where cars are standing, another engine should be used to take these cars to tracks that are already cleared. If a rotary cannot be obtained a double track plow will serve the purpose. I might add that our rotary is equipped with wings which remove snow for a distance of seven feet from the center of the track, thus avoiding the necessity of employing a large force of men to widen cut. There are but very few obstructions on our main track which will not clear our wings but when obstructions are encountered the wings can easily be closed in about two minutes. Last but not least a man should be chosen to take charge of removing snow, who is thoroughly familiar with the best methods of removing same.

Very few people who ride over a railroad know anything of the amount of necessary work to be done to keep the track in safe condition and to make cars ride smoothly. Track maintenance is exceedingly hard work at any season of the year but especially during the winter months. The duties of the track forces are of the most exacting and vigorous nature. This is particularly true for protection of the traveling public. Yet the track forces' efforts are generally unappreciated. This is often due to the fact that the responsibilities of the work in which they are engaged are not thoroughly understood by those outside of the track department, for very few people realize how many chances there are for derailment of trains. Were it not for the vigilance and close attention of the maintenance of way men to duty, the appalling record of accidents would be greatly increased. But their existence makes itself manifest if they overlook one of their many important duties and it results in an accident. It is therefore self evident that the track forces are a very important factor in the safe and successful movement of trains. The records of results show that the trackman fulfills the trust reposed in him more satisfactorily than some of the men in the other departments. Thus the safety of trains so far as the maintenance of way is concerned is well established in the integrity of the employes of this department.

BURNING, TO CURE "GUMBO" SLIDES.

J. J. Hess, Assistant Engineer Maintenance of Way.

We have a good many sink-holes in Minnesota swamps that cause trouble, and settlement is overcome by taking soundings and loading until the bottom or solid ground is found, after which no further bother is experienced.

Various methods are employed for handling slides, depending largely upon the nature of the soil and local conditions. They sometimes develop because conditions are such that not sufficient berm can be left out of the natural ground to withstand the load, or where it is difficult or expensive to properly drain borrow pits.

Fills also sometimes start sliding on account of being constructed by trestle work or by use of too heavy material used for ballast before roadbed has a chance to become solid and settled.

It is also frequently the case that the original ground is of such a nature as to not withstand load. Slides are also sometimes produced by insufficient waterway being provided, causing seepage through and against fills.

Slides in cuts can be prevented by the establishment and maintenance of surface ditches, except of course, in mountains where slides are usually caused by snow thawing, combined with frost going out, together with rains.

Trouble is avoided from latter by digging trenches in snow on the sides of slopes, thereby diverting water to where openings are established, and at ends of cuts. It also prevents gravel, rock, mud, sand, etc., from washing and rolling upon tracks. This, together with keeping track ditches cleaned out, is the best method the writer found of avoiding trouble.

In cuts, other than in mountains, it has been found a good thing to plant grass on slopes. The same thing is a great help on fills.

Cinders are about the best thing to use in emergency cases. Being light, they do not add much to the weight of fill, and they absorb water.

Where borrow pits are the cause of sink holes, they should be refilled. Where caused from lack of drainage and insufficient waterways provided, steps should be taken to remedy same.

Where strata of ground or different composition of earth come in contact with each other, or where sliding strata are known to be below the ground surface, it has been found to be good practice to dig a trench below the sliding strata and fill with stone.

In some instances where fills are built on side or slopes of hills, a trench is dug on the upper side, filled or walled with rock, to divert water and avoid seepage.

I have seen some bad slides checked and stopped, where earth consists of gumbo, by the burning of old ties on sides of banks and at toe of slopes. The gumbo forms a dry cinder, something on the order of burnt ballast, and by absorbing the water, answers the purpose intended. The driving of piling, establishing of retaining walls and blind drains, the latter consisting of looser rock which permits water to pass through, have been found to be good preventives and checks to slides.

LARGER SECTION GANGS, WITHOUT EXTRA GANGS.

By Emil Knack, Foreman.

There has been much discussion on the question of extra gangs, and in my opinion not without foundation. There are different opinions regarding extra gangs and their work, and I will submit mine in the following lines:

In my opinion section crews should be made large enough to handle all regular maintenance work. If a foreman can get from ten to fifteen good men, all the general maintenance work, without any assistance from extra gangs, can be done.

Combining section crews to do relaying, raising, etc., has its disadvantages as well as its advantages. By combining crews a much better grade of work can be had than with an extra gang, due largely to the experience of the men in regular section crews. But on the other hand, taking the crews off of their sections for any length of time to help on other sections, often results in bad track, which would not happen if the crew were on the job each day. A short time, say a week or ten days,

I find in my experience, does not make a great deal of difference. By delaying the work in this manner, it often runs into the cold weather before the track is back in proper shape.

Extra gangs, as a rule, are far from being as efficient as section crews, owing to a great extent to their inexperience.

The work of extra gangs, in most cases, does not stand up well. This is due to the rapidity with which the work is gone over, as well as the inexperience of the men in raising track and putting in ties. They do not tamp the way they should, and therefore the section crews are obliged to go over their work and spend most of their time getting the track in good shape. If the work was originally done by experienced men, as regular section crews, this later expense would be eliminated.

To obtain good men in an extra gang is surely a hard proposition. Foreigners are the most easily obtained and therefore usually compose the extra gangs. Of course the grade of work resulting from foreign labor is not what it would be if American labor could be procured.

Ballasting track is a difficult proposition with a regular section crew. If no more than three or four inches of raise is to be made, a foreman with fifteen men can do the work. But if more than four inches is made, more help would be needed. I find that fifteen experienced men can do as much work as double that number or more of the less experienced ones.

Extra gang foremen are picked out according to their efficiency and experience. To handle an extra gang, a man must have had plenty of experience in all round track work, and be able to handle men.

I find that some foremen can handle a crew and get more work out of the men than others, although the latter may be just as good track men. The former are the one's that are usually picked out for extra gangs.

Probably one-half of all the section foremen I know are capable of handling larger gangs in reballasting and relaying. It requires grit, a thorough knowledge of track work, and the ability to handle men to run a large gang and make a success of it.

ECONOMICAL MAINTENANCE.

By Fred Kimball, Foreman.

When extra gangs are hired, extra foremen are hired to take charge of gangs at a higher rate of pay than section foremen, and usually those foremen are either the class of men that are looking for 6 o'clock and pay day, or the gabby, hustling foremen who want to make great records for themselves. Such a man knows that he does not have to maintain the work after it is completed; that it is up to the track foreman on each section. Many times it takes the foreman 3 or 4 years to get the track back in as good condition as it was before the extra gang ripped it up for him.

More track can be put out of commission in three months than can be put in good condition again in three years by a good, competent foreman.

My method for economical and efficient extra work would be: Increase section gangs to a force of fifteen or sixteen men, and in reballasting use three gangs and one competent foreman, with full authority over the men and foremen under him. Then he must impress upon the minds of all under him the necessity of the work being well done, as the same men have got to maintain it in the future. Then each foreman will see the necessity of digging right in to attain the end for which the chief foreman is working; a lasting and efficient job.

In relaying rail, four gangs should be used, with one foreman in full charge, which would leave three other foremen as assistants, to be placed by the chief foreman thus: One to look after the pulling of spikes and adzing; one to look after the bolters; and one to look after the spiking and gauging. The chief would lay the rail and make all connections with two good, wide awake men to look after the truck and pick up all scattering tools and to rush the truck ahead at the chief's command when a connection is to be made. The chief foreman should keep watch to see that his foremen do not get bunched for they will get into an argument and neglect their business. He must also see that no foreman stands with his hands on his hips and talks to any of the laborers any length of time, as that is the fault of extra gangs. Too much time is spent in talk and not enough in work. The same fault is liable to exist in all large gangs.

In picking men for chief foremen, I think that the supervisor and roadmaster should both decide on the man and see that they get a competent man. Don't allow a pet or personal friend to be chosen. The chief foreman should receive an extra compensation while at this special work.

RAIL RAVELINGS.

Dear Son: In a recent issue of a publication devoted to the interest of railroad employees I noticed an article in regard to the preparations made after an "underground message" had been sent out stating that on a certain date a train carrying some of the "big" officials would go over the line. Immediately a general buzzing begins which when analized sounds like this, "the Brass Collars are coming." At such times the petty officials, sometimes even the division superintendents, seem to lose all interest in everything except "cleaning up," and as a consequence the operating and maintenance departments are to some extent demoralized until the great event is over. The roadmaster or supervisor is usually the one who gets the worst of it, as the section men are taken off their regular work, no matter how important, and put to cleaning up.

I recall some instances of this kind. A roadmaster had issued an order for his men to rush all ties on hand into the track, the time for completion of the work being limited to a certain date when the section forces were to be reduced to the minimum. An official train was announced and the word passed to "clean up." The tie business was called off and everybody was put to cleaning up. As is nearly always the case a lot of unnecessary work was done, the consequence being that when the time came for the reduction of the force, the ties were not all in. The roadmaster protested, but to no purpose. The force was cut and the ties carried over to the next season to the detriment of the track. Had the work been done as planned by the roadmaster, the ties would have been put in while he had sufficient force for that kind of work, and the necessary cleaning up done with the reduced force. And I can recall instance after instance where practically the same thing has occured and always to the detriment of the necessary work of the section men; for at such times the cry of "go get a section man" is carried to the extreme and they are called upon to do all kinds of work, such as cleaning up around repair yards and shops, washing windows, etc., which does not concern them under ordinary circumstances.

The disturbance of normal conditions extends to other departments as well. Only recently an instance came under my personal notice as follows: A train was announced to go over a new branch line, carrying the general officers of the company. After several postponements, each one of which caused fresh preparations, the trip was finally made. The train crews were held in the terminal for hours in order to put them out so as to have a train standing on each siding to show up to the people on the special train. Some of these trains were held on the sidings for hours to try to keep up the delusion that the road was doing a rushing business. Did any one figure the cost? If so, they probably discharged a few section men to make up the deficit. Occasionally an official who has "worked up from the ranks," understands these things but seldom comments on them. One instance comes to my mind when an official noticing the trains all lined up on the sidings, all headed one way, as in the above instance, turned to the assistant superintendent and said, "Jim, how are you going to get them all back?"

The practice of hiding men out as mentioned in the article

alluded to at the beginning of this letter, is resorted to in a good many cases to "pull the wool over the eyes" of officials and directors. At one time I was filling in around a new office building, using several teams and a number of laborers. A special train with officials aboard was going over the road and I was ordered to keep everybody out of sight. I took the teams and men to an adjacent lumber yard where they remained for about three hours before the train passed. There were a couple of side tracks between the main line and the office and these were filled with box cars to hide the work that was being done from the eyes of the party on the train.

At another time I took an extra gang of 40 men with their tools and kept them out of sight until a special train with officials had passed.

The latter instances happened a good many years ago. To the men in the ranks who have to make a showing for every penny spent, these practices do not look like business, and frequently bring forth the remark that if a private business was conducted in this way it could not possibly exist. This inevitably brings one to the conclusion that if the general officials of a railroad really cared to know the manner in which the details of operation and maintenance are carried out, their trips over their prospective roads would not be announced.

DAD.

Correspondence.

CREEP OR TRAVEL OF RAIL.

Editor Railway Engineering:

I would like to hear the opinions of some experienced practical men as to the remedy for creeping rail, through the medium of your paper.

This is one of the greatest difficulties with which the Permanent Way men in India have to contend, and is a most troublesome problem. When we come to inquire in which direction creep takes place and when, it is almost impossible to give a satisfactory reply.

(Signed) AMIN CHAND KAPUR,
Permanent Way Inspector,
Jullunder Doab Railway, India.

PATENTS AND INVENTORS.

Editor *Railway Engineering:*

The ordinary railroad man seldom regards his position or the position of any of his "railroader" friends as being romantic or unusually fascinating. Instead, he considers it from a practical standpoint of everyday hard work and not infrequently as a monotonous "grind." The "outsider," however, usually considers railway work fascinating, romantic and highly remunerative. Personal experience alone is not responsible for the above statement. A glance into almost any railway journal or publication bears out the fact. Scarcely a single publication can be found that does not contain descriptions or advertisements of new railway inventions by the score. An examination of these inventions almost invariably reveals some of the most worthless, impractical and costly appliances conceivable. An experienced railroad man recognizes the impractibility of these appliances at once and hence the invention of the article cannot be placed at his door.

Investigation usually shows that the inventor is a novice, or else a "romantic" outsider, such as a drug clerk, barber, teamster, etc., whose knowledge of railroading consists of riding in a railway coach on a few occasions.

Present day railroading has advanced to a stage where there are few mechanical improvements apparent, except to a man who has had railroad education and experience.

The menace of the type of men exemplified by these so-called inventors lies in the false conception of railroading that these men possess. Many are led by this false conception to apply for railway positions and in order to experience the anticipated pleasures they accept low salaries and thus the scale of wages remains low—lower than the same experience and ability brings in almost any other commercial line.

The sooner the true facts of railroad work and life become known generally, the sooner will the teamster, drug clerk, barber, etc., cease to long for the life of a railroad man and the quicker true ability and experience be recognized in the pay check.

C. E. FOREMAN.

DRAINAGE.

By D. O'Hern, Roadmaster.

The stability of the track depends upon the strength and permanence of the road-bed and structures upon which it rests; whatever will protect them from damage or prevent premature decay should be carefully observed.

The worst enemy is water, and the further it can be kept away from the track, or the sooner it can be diverted from it, the better the track will be protected. Cold is damaging mainly by reason of the water which it freezes; therefore, the first and most important provision for good track is drainage.

All new ditches should be dug, and old ditches cleaned before the first day of November of each year. Put in cross drains wherever it is necessary. Ditches, box drains and culverts must be inspected often and cleaned of all driftwood and trash.

It is the duty of the foreman to go over his section after every heavy rain and see that all drains are free from brush and driftwood.

Channels and streams for a considerable distance to the right and left of the road must be frequently examined and cleared of brush, drift and other movable obstructions.

All clay cuts should be tiled with drain tile placed down below freezing point, ditch to be filled up with cinders as high as sub-grade. Anything washing down from the slope of the bank should be cleaned off by the first of November. Where there are high cuts, a surface-ditch should be dug about three or four feet back of edge, both ways, from top of the cut parallel with track, down to the bottom of cut so as to prevent a slide caused by water running over the slope of the cut.

All track men know that water is their worst enemy in maintaining the roadbed; the further and quicker they can get it away from the track the better.

No matter what ballast you have, you cannot maintain track well with the water close to track.

ATTITUDE TOWARD TRACK MEN.

J. J. Bethune, Roadmaster.

I am in favor of regular section gangs doing all regular maintenance work and keeping the foreman on his own section, and when doing heavy work, such as reballasting, etc., giving him the necessary number of extra men in addition to his own crew to handle the work.

I do not approve of doubling up section crews, as there is considerable time lost in going from one section to the other. Besides, it is poor policy to leave a section vacant, especially in case of an accident happening on a section.

It is much better to add men to a regular gang than employ all new men under one foreman, as the regular experienced men, as well as the foreman, will instruct the new men. Work done in this way is more efficiently done, and is permanent.

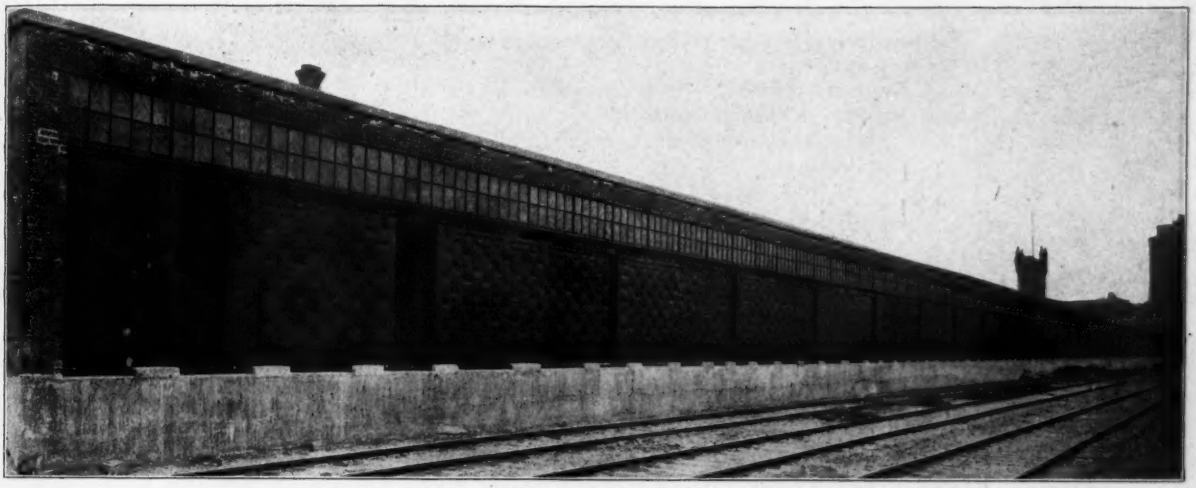
In reballasting, for instance, it takes some time to educate most laborers to tamp ties properly, and if the tamping was done by an extra gang of green men it would be very poorly done. But by having the regular section men and pairing them up with new men, in a short time all would be fairly efficient.

Our foremen as a rule are capable of handling all the men that are necessary in addition to their gang, in reballasting and putting in new ties, and make the men earn their money, too, as the regular foreman on his own section is always anxious to get as much work done as possible, and get it done right, as it

will make it easier for him in future to maintain his track in good condition.

We draw our extra gang foremen from our section foremen. We choose the man who is most fitted to handle men and make a large gang work to advantage. There are, of course, some section foremen who are fairly well qualified to maintain a section with the limited section gang, but would be all at sea if given a large gang to handle.

Give me the man who can get work out of every man. We can always get such men in the east. One reason is that all our section forces must have a good knowledge of reading, writing and arithmetic. Just as soon as railway companies realize the fact that a trackman requires as much intelligence as a brakeman or fireman, and recognize the trackman as a mechanic (and not as a navvy), which he must be to be efficient for his work, and remunerate him accordingly, then, and only then, will track maintenance be done efficiently and economically. And good men will always be available for promotion to take charge of important work and large gangs.



Track Side of One of the Wings of the Toronto Freight House, C. P. Ry. Richards-Wilcox Door Equipment.

SLIDES ON MOUNTAIN TRACK.

By S. Cheatham, Roadmaster.

We have our railroad built over a small mountain at Alto Pass. The grade on this hill ranges from one and one-half to two per cent, and we have been bothered a great deal with slides. We have had slides show up in one night's time in the spring of the year when the ground was wet and the track would slip six inches out of line. We have been compelled to keep men out both night and day in order to maintain traffic. I have tried out piling, driving them on the lower side of the fills, but the best thing I have ever tried is common drain tile. We dig into the foot of the dump and into the center of the track as near as we can get it, and lay drain tile, cover in on top of the drain tile with three feet of cinders and fill the balance of the way with dirt; also use cinders exclusively for ballast, as the cinders will help take the water and will eventually stop the slide.

The material that is under the road bed at points where we are bothered with these slides, is a kind of soap stone.

I find that cinders are the most practical material to use in the track when you have slides, soft places or wet cuts. For any place where your track is wet and soft, my experience has been that there is nothing better than cinders.

TORONTO FREIGHT HOUSE, C. P. RY.

The Canadian Pacific Ry. has recently completed a freight station of modern design at Toronto, Ont. The building measures 433 ft. 11 ins. across the front, in which are offices; the freight station proper is composed of two wings built onto the back of the office section. The wing for inbound freight is 949 ft. 7 in. long and 30 ft. wide, while the inbound section is of equal length and 50 ft. wide.

Between the two wings there is an open space 104 ft. wide in which are located seven tracks, and a transfer platform.

This design of freight house is out of the ordinary, and has a number of advantages. Each wing is arranged to serve teams on one side and cars on the other—this feature provided double the team loading capacity of the ordinary type of shed. The wings of the building entirely hide cars and operations from view, and thus greatly improve the appearance.

The greatest advantage is the increased capacity afforded. From 14 to 18 cars may be accommodated at each platform, and the confining of unloading operations to one wing and loading to the opposite wing, reduces confusion, makes work easier and gives greater rapidity, and finally, greatly reduces the chance for errors in shipping. The separation of loading wagons and unloading wagons also decreases the confusion and friction and increases the capacity of both teams and freight shed.

Especial attention is directed to the wide trucking space made by opening the doors. The amount of useless space is reduced to a minimum by these doors, of the Richards Wilcox type, with parallel door hangers. This is in keeping with the desire to reduce obstructions or interference to the minimum, in truck operation.

The building is devoted mostly to the one story inbound and outbound freight wings, but there is in addition a warehouse three stories high, freight offices three stories high, and a section ten stories high containing freight offices.

The tracks are stub ended, at the back of the front or office section of the structure. Two heavy, multiple track type concrete buffers are used at these stub ends. A buffer is located on each side of the transfer platform, one buffer obstructing the end of five tracks, the other three tracks.

The entire layout is interesting as an example of advanced and careful design, made to conform to the practical conditions to be met.

Samuel N. Pond and Ira J. Wilson, the former having been associated with the firm of Offield, Towle, Grages & Offield, and the latter having been associated with Innthieum, Belt & Fuller, have formed a partnership for the practice of patent and trademark law. The law firm is known as Pond & Wilson and has taken offices in the Monadnock building, Chicago. Both Mr. Wilson and Mr. Pond have had long experience in patent law and their success is assured.

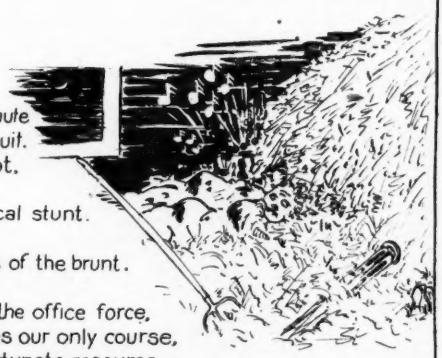
The Engineer's Distress

Copyright, 1914, W. E. Magraw

A.S.Gunn Editor

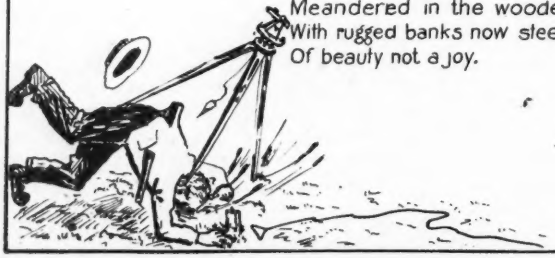
A Short Survey

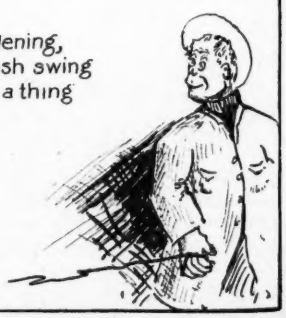
By C. LeAnnon



An enterprize upon a scale which might be termed minute
May yet demand attention such as magnitude would suit.
These incidental jobs are dreadful nuisances to boot.
In very fact.
There are 15 miles of line to run at once, a local stunt.
No party is available as all are at the front,
Tis ordered by the powers that be, regardless of the brunt.
Someone must act.
I have it says the chief at last, "We'll take the office force,
And let the drafting go awhile, it seems our only course,
They've all had some experience, a fortunate resource,
Set out at once!"
"The instruments, your blankets and a team is all you need.
You can sleep in barns on hay mows and forage for your feed,
In this October weather 'twill a picnic be indeed
Just for nonce"
That party was a motley gang of tender feet and toughs,
Four soft men from the office, though not exactly muffs.
The flotsam of our little town contributed the roughs.
Not bad at that.

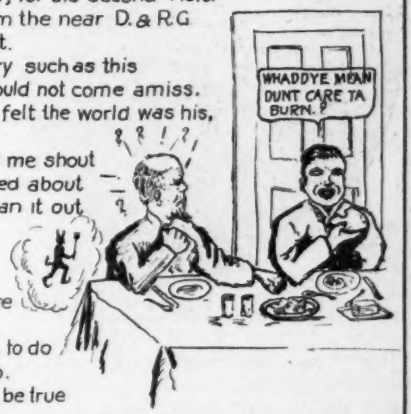
A Mick, a German and a Swede, a Cracker and a Yank,
As roustabout a nondescript with a capacious tank.
A teamster from old Tennessee, droll goateed and lank.
A jovial frat.
The farmers on the river had migrated from the South,
They had a sort of hookworm gait, appeared down in the mouth.
Would sit around and chew and squirt, and curse the soil and drouth.
A wretched lot.
Yet they were hospitable and for a moderate fee
Were quite accommodating for all their misery
But where a thing does not exist it cant be had you see.
It can't be bought.
The boiled salt pork and cabbage in rusty dishpan served,
Was hardly appetizing though healthy hunger nerved,
The hardiest among us eventually swerved
The slushy pot.
Some nights the lack of shelter put us in a sorry plight
We huddled in the wagon box upon a frosty night
And cramped and shivered sociably until the morning light
When we got up.
The doings of that party were quite typical enough
To merit some description, hence the bald ensuing stuff
Hurry was the word of course, and all that line of guff
The time to well employ.
The river crooked itself through rocky clefts, then broadening,
Meandered in the wooded swamps with bold and sluggish swing
With rugged banks now steep, now benched, then sloping fair, a thing
Of beauty not a joy.





The first hub driven, the transit set, the chain laid out at length,
The giant at the head jerked once, exertin all his strength,
The chainman at the tail held on and forward sprawled full length.
The instrument was down.
The old man fetched a gulp, then swore and clutched his swelling neck
The transit down seemed fully out, a battered useless wreck.
To put it in adjustment took a thirty dollar check
He had a right to frown.
And yet those 15 miles were run with that same instrument,
The plates were sprung and bearings chafed and many a screw was bent.
The survey was completely made before to shop it went.
Its make was of the best
One chilly morning on the line we reached an awkward ditch.
A running jump would cover it but just here was a hitch
That transit was quite heavy and the net result of which
Was rather void of zest.
In water to the armpits but with transit held on high
His comrades fish him out and stand him on the swamp to dry
The timber is so heavy that he cannot see the sky,
But it shelters from the wind.

The axemen swing quite manfully and in the course of hours,
They hew a path to sunlight as he lines them in and cowers.
Oh glorious freedom of the wild fast in these leafy bowers,
And so on – in your mind.
One day we tried to fit a curve around a rocky rim
The margin was too scanty and the day was growing dim.
"We'll run an angle line" says he "and by the candles glim
We'll work it out tonight."
A curve four time compounded fitted nicely to a Tee.
We had to build a crib though, for the second P.C.C.
Some ties hypothecated from the near D. & R.G.
Helped fix things out all right.
A tangent of goodly length in country such as this
Would something of a wonder be, it would not come amiss.
The old man scouted and explored, he felt the world was his,
A tangent he foresaw.
I'm going up the line a piece and when you hear me shout
"Set on my voice." A foresight on a voice appeared about
The limit. Listen! Where?!!! We leveled up and ran it out
But slipped up in the draw.



That truly was a random line, though serving as a base
By taking a long offset at a quite convenient place
With a foresight on a distant peak, the line stretched out apace
Four miles without a turn.
We struck a piece of luck one night, a farmer well to do
Housed part of us and fed us all, a canny genius too.
"I jined the church," said he "becuz hell preachin may be true
An' I dunt care ta burn."
Our roustabout, observant chap, liked well to raize a laugh,
His wisdom was diverting, even more so than his chaff.
"If that's a thirty minute curve this one's an hour'n a half."
He said in sober vein
As a concluding episode of this survey renowned,
We ran into a haystack we thought beyond our bound,
There was nothing to be done except triangulate around
And miss our homeward train.

Personals

Operating

Although we are publishing monthly in these columns a practically complete report of all appointments of interest to our readers, it is probable that this information could be published earlier if each subscriber would make it his business to notify us of new appointments immediately. We request and we shall appreciate your assistance in this respect.

W. J. EDWARDS, formerly roadmaster, has been promoted to superintendent of the *Alabama Great Southern R. R.*, office at Birmingham, Ala., succeeding J. W. Evens.

F. J. EVANS, formerly trainmaster, has been promoted to superintendent of the *Atchison, Topeka & Santa Fe Ry.* at Clovis, N. M., He succeeds J. E. MCMAHON, appointed superintendent at Pueblo, Colo., vice C. H. Bristol, promoted, as announced in the February issue.

J. N. BRAND, general superintendent of the *Atlantic Coast Line R. R.* at Savannah, Ga., has been appointed general superintendent at Jacksonville, Fla., succeeding Morton Riddle. R. A. MCCRANIE, formerly superintendent, has been promoted to general superintendent at Savannah, Ga., succeeding Mr. Brand. O. T. WARING, formerly engineer of roadway, has been promoted to superintendent at Waycross, Ga., succeeding Mr. McCranie.

J. W. MEREDITH, General Superintendent Central Railroad of New Jersey.

W. J. EDWARDS, Superintendent Alabama Great Southern R. R.

D. VAN HECKE, Superintendent Chicago, Rock Island & Pacific Ry.

J. W. MEREDITH has been appointed general superintendent of the *Central R. R. of New Jersey*, office at New York City, as announced in our February issue. He entered railway work as station agent on the above railway in 1885, was made agent in 1886, and extra agent, New Jersey Southern division, later. He was appointed train dispatcher in 1887 at East Long Branch, and trainmaster at the same place in 1897. He was appointed superintendent at East Long Branch in 1911, holding that position until his recent appointment was effective.

C. H. STEIN has been appointed superintendent of the *Central R. R. of New Jersey* at Jersey City, N. J., as noted before in these columns. He was born July 28, 1871, at Baltimore, Md., educated at the Baltimore City College, and entered the service of the Western Maryland R. R. in 1890 in the engineering department, where he served successively as rodman, instrument man and assistant engineer on location and construction work. He was transferred to the maintenance of way department, in charge of engineering work in 1893, became assistant roadmaster in 1901, and left to go with the P. & R. Ry. as assistant supervisor in 1903. He served as assistant supervisor from 1903 to 1905 on main line and branches, became supervisor of the main line in 1905 located at Bridgeport, Penn., and left the service of the P. & R. Ry. in 1907 to become engineer maintenance of way of the Central R. R. of New Jersey, in which capacity he served until February 1, 1914, when he was promoted to division superintendent. He is a member of the American Society of Civil Engineers, and is chairman of committee No. 9 of the American Railway Engineering Association.

S. B. ZARTMAN has been appointed superintendent of the *Central R. R. of New Jersey* at Long Branch, N. J., as noted in our February issue. He began railway work in 1883 and was employed on railway engineering and construction during vacations while attending college. Later he was employed in various capacities in the traffic and transportation departments. He held successively the positions of trainmaster, P. & R. Ry., superintendent of construction, St. L. & M. Ry., superintendent, St. L. & K. C. Ry., superintendent of terminals, S. A. L. Ry., and general agent, Central R. R. of New Jersey. He was promoted from the latter position to superintendent, February 6.

Following a rearrangement of the general divisions of the *Chesapeake & Ohio Ry.*, J. R. CAREY has been transferred to Clifton Forge, Va., as general superintendent of the eastern division. The new arrangement is as follows: The Richmond, Clifton Forge and Hinton divisions constitute the Eastern general division; the Huntington division and Big Sandy district constitute the Central general division; the rest of the lines west constitute the Western general division. J. P. STEVENS has been transferred to Huntington, W. Va., as general superintendent of the Central division. J. A. FOX, formerly at Covington, has been appointed superintendent at Ashland, Ky., following the extension of his jurisdiction over the Ashland division. L. B. ALLEN formerly engineer maintenance of way, has been appointed superintendent at Huntington, W. Va., succeeding E. J. King.

P. L. MCMANUS, formerly superintendent, has been promoted to general superintendent of the *Chicago, Indianapolis & Louisville Ry.*, office at La Fayette, Ind., assuming the duties of A. H. Westfall, general manager, resigned to enter private business. Mr. McManus was born at Chatham, Ill., June 22, 1865, and graduated from the public schools in that town. He entered railroad work as water boy on the section, with the Chicago & Alton Ry., at Chatham, Ill., in 1879, and was later operator, agent, train dispatcher, brakeman and switchman with that company. In 1895 he went with the E. J. & E. R. R. as telegraph operator, and later was cashier, agent, general agent and general yardmaster at Joliet, Ill., until 1902, when he went with the Southern Ry. and was until

1910 traveling yardmaster, inspector of transportation, chief clerk to the vice president and general manager, assistant superintendent, division superintendent and assistant general manager. During 1910 he was engaged in the coal mining business as secretary and general manager of the Barney Coal Co., at Birmingham, Ala. In 1911 he returned to the Chicago & Alton as yardmaster, and was later trainmaster and superintendent of terminals. In 1912 he went with the C. I. & L. Ry. as inspector of transportation and was appointed superintendent, which position he held at the time of his recent appointment.

J. M. BATHS, formerly trainmaster, has been promoted to superintendent of the *Chicago, Indianapolis & Louisville Ry.* at La Fayette, Ind., succeeding P. L. MCMANUS, promoted. W. H. FOGG, formerly trainmaster, has been promoted to superintendent at La Fayette, Ind. D. E. MURPHY, formerly trainmaster, has been promoted to superintendent at South Hammond, Ind.

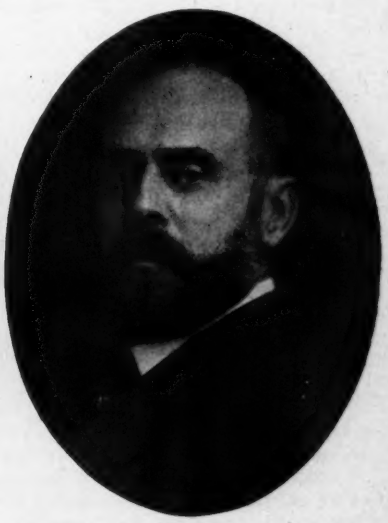
D. VAN HECKE, formerly trainmaster, has been promoted to superintendent of the *Chicago, Rock Island & Pacific Ry.* at Amarillo, Tex. He succeeds A. E. WALKER, appointed superintendent at El Dorado, Tex., succeeding C. Davis.

E. E. KERWIN has been appointed general superintendent of the *Minneapolis & St. Louis R. R.*, office at Minneapolis, Minn., succeeding C. S. Lake. He was born at Turner, N. Y., December 18, 1861, entered railway service as a water boy with a section gang on the New York, Lake Erie & Western R. R., and was later trackman, operator and agent at various points in New York and New Jersey. From March, 1885 to 1890 he was operator, agent and dispatcher with the Union Pacific R. R., Chicago, Milwaukee & St. Paul Ry., and Chicago, St. Paul & Kansas City Ry. Mr. Kerwin was trick dispatcher on the Iowa Central Ry. at Marshalltown, Iowa, from March, 1890, to May, 1893; chief dispatcher of the same road at Keithsburg, Ill., from 1893 to 1895 and trainmaster at Oskaloosa, Iowa, from 1895 to 1902. From November, 1902, until he recently resigned to take his new position at Minneapolis, Minn., he was superintendent of the Central R. R. of New Jersey at Jersey City, N. J.

As announced in our February issue, A. E. POTTER has been appointed president and general manager of the *Narragansett Pier R. R.*, office at Providence, R. I. He entered the employ of the Rhode Island Co. in 1892 in the track department, and remained

E. E. KERWIN, General Superintendent Minneapolis & St. Louis Ry.

E. D. LEVY, General Manager St. Louis & San Francisco R. R.



CHARLES S. CHURCHILL, Asst. to President Norfolk & Western Ry.

J. T. TAFFANY, formerly division engineer, has been promoted to trainmaster of the *Erie R. R.* at Buffalo, N. Y.

Effective February 10, M. RIDDLE was appointed general manager of the *Florida East Coast Ry.*, office at St. Augustine, Fla. He was born in 1869 and entered railway engineering work with the N. & W. Ry. in 1887. Later he was employed by the C. C. C. Ry. and left to go with the A. C. L. R. R. In 1900 he was appointed superintendent, was promoted to assistant chief engineer in 1904, and to general superintendent January 1, 1905. He held the latter position at the time of his appointment as general manager as noted above.

A. L. MILLS has been appointed general manager of the *Fort Smith & Western R. R.* at Fort Smith, Ark., succeeding W. M. Bushnell.

H. A. BOOMER has been appointed general manager of the *Lake Erie & Western R. R.*, office at Indianapolis, Ind. His first railway work was with the Wabash R. R. and the St. Louis & Western Ry. For the last eighteen years he has been in the employ of the L. E. & W. R. R. as superintendent, assistant general superintendent, and general superintendent, holding the latter position at the time of his appointment as general manager.

C. W. HUNTINGTON, formerly general superintendent of the Central R. R. of New Jersey, has been appointed vice president and general manager of the *Minneapolis & St. Louis R. R.*, succeeding W. G. Bierd, resigned to become president of the C. & A. Ry.

in that department until 1895, when he was appointed assistant to the superintendent of conductors and motormen, and continued in this capacity until 1897, at which time he was placed in charge of the department as superintendent. In 1900, when the office of superintendent of transportation was created, he was promoted to that position, and on January 1, 1906, he was promoted to general manager, holding the latter position until his appointment as noted above.

C. W. AKERS, formerly at New Bern, has been appointed superintendent of the *Norfolk Southern R. R.* at Raleigh, N. C., succeeding Geo. A. Bradley. J. C. LEWIS has been appointed acting superintendent at New Bern, N. C., succeeding C. W. Akers.

WARREN SHERMAN PALMER has been appointed president and general manager of the *Northwestern Pacific R. R.* at San Francisco, Cal., as announced in our February issue. He graduated in civil engineering at the age of 18 from the University of California, and was employed for four years in the bridge department of the Central Pacific R. R. as draftsman, and later as designer. He served eight years as rodman, instrument man and chief of party on location and construction, and in 1890 was appointed resident engineer for the Southern Pacific Co. Later he was appointed division engineer and in 1898 assumed also the duties of assistant superintendent. He was appointed superintendent in 1901 and general superintendent in 1905. In 1907 he was appointed general manager of the Northwestern Pacific R. R., and in January, 1914, was elected also president, as noted above.

As noted in our February issue, G. LE BOUTILLIER has been appointed superintendent of the *Pennsylvania Lines West* at Richmond, Ind. He entered the service of the Pennsylvania lines in 1900, in the chief engineer's office. He was appointed assistant engineer, Pittsburgh division, in June, 1900, transferred to the Richmond division in November, and to the Cleveland division in August, 1901. In July, 1903, he was promoted to division engineer, Cleveland division. He was transferred to the Cincinnati division March 1, 1905, and to the Pittsburgh division November 1, 1912, holding the latter position till his present appointment as superintendent of the Richmond division, effective February 1.

E. D. LEVY has been appointed general manager of the *St. Louis & San Francisco R. R.*, office at Springfield, Mo., succeeding W. T. Tyler, resigned. He was born at Paris, Tex., October 16, 1879, and entered railway service as a stenographer for the Santa Fe Refrigerator Dispatch February 1, 1898, later serving as stenographer on the C., M. & St. P. Ry., office of general superintendent. He was employed on the A., T. & S. F. Ry as secretary to the industrial commissioner, and later was secretary to W. C. Nixon, at that time superintendent. He was later stenographer in the following offices: Master mechanic, at Needles, Cal.; master mechanic, Ft. W. & D. C. Ry.; vice president and general manager, Mexican Central Ry. He re-entered the service of Mr. Nixon as secretary, who was then general superintendent. He was appointed transportation clerk on the G. C. & S. F. Ry. and was appointed to senior clerk in the general manager's office April 30, 1903, and promoted to chief clerk to the general superintendent May 1, 1909. He entered the service of the St. L. & S. F. Ry. August 15, 1906, as assistant superintendent of car service, and was promoted to assistant general manager May 1, 1911, which position he held till March, 1914, the date of his appointment as general manager.

J. M. CHANDLER, formerly superintendent of the *St. Louis & San Francisco R. R.*, at Enid, Okla., has been transferred to Francis, Okla., succeeding C. F. Hopkins, transferred. C. H. CLAIBORNE, formerly assistant superintendent, has been promoted to superintendent at Chaffee, Mo., succeeding O. H. McCarty, transferred. J. H. DOUGHTY has been appointed acting superintendent at Birmingham, Ala., succeeding J. H. Jackson. C. F. HOPKINS has been appointed superintendent at Sapulpa, Okla. O. H. MCCARTY has been appointed superintendent at Chaffee, Mo. C. T. MASON has been appointed superintendent at Enid, Okla.

T. B. COPPAGE has been appointed superintendent of transportation of the *St. Louis & San Francisco R. R.*, office at Springfield, Mo. He began railroading with the L. & N. R. R. as a station helper and operator in 1878, and after a service of about two years as telegraph operator took service with the old Queen & Crescent Route and remained with them for eleven years, located at Somerset, Ky., as operator, train dispatcher, chief dispatcher, trainmaster, freight conductor and general yardmaster. He afterward took service with the old L., N. O. & T. Ry. at Greenville, Miss., as assistant superintendent for two years, then went with the A., T. & S. F. Ry. at Marceline, Mo., as chief dispatcher for a period of about a year. He was with the St. L., I. M. & S. Ry. at Van Buren, Ark., as chief dispatcher and trainmaster for a period of six years, and then with the G. C. & S. F. Ry. at Temple, Tex., as trainmaster and superintendent for a period of five years. He went with the Frisco Lines April 1, 1907, in the capacity of superintendent, which position he held till his recent appointment, noted above.

E. E. Calvin, vice president, having resigned to accept service with another company, W. R. SCOTT has been elected vice president of the *Southern Pacific Co.*, in addition to his present position of general manager in charge of operation and maintenance, office at San Francisco, Cal. D. W. CAMPBELL, formerly general superintendent, has been promoted to assistant general manager, office at Portland, Ore. H. V. PLATT, formerly general superintendent, has been appointed assistant general manager at Los Angeles, Cal.

F. A. BRAINERD, formerly trainmaster, has been promoted to superintendent of the *Spokane, Portland & Seattle Ry.*, office at Vancouver, Wash., succeeding J. P. Rogers.

T. S. MAHONEY, formerly terminal superintendent, has been appointed division superintendent of the *Texas & Pacific Ry.* at New Orleans, La.

As noted in our February issue, THOMAS BENTON HAMILTON has been appointed general manager of the *Vandalia R. R.*, office at St. Louis, Mo. He was born August 7, 1865, at Columbus, O., graduated from Princeton University in 1888, and entered railway train service November 18, 1888, as rodman on the Jeffersonville, Madison & Indianapolis Ry., at Louisville, Ky., since which time he has been consecutively from January 27, 1890, to January 1, 1896, assistant on engineer corps Pittsburgh division Pennsylvania Lines West; January 1, 1896, to May 1, 1897, assistant engineer Pittsburgh division; May 1, 1897, to April 1, 1898, engineer maintenance of way Toledo division Pennsylvania Co.; April 1, 1898, to April 1, 1890, engineer maintenance of way Cincinnati division Pennsylvania Lines West; April 1, 1900, to June 1, 1901, engineer maintenance of way Cleveland & Pittsburgh division Pennsylvania Co.; June 1, 1901, to December 21, 1903, superintendent Erie & Ashtabula division, same company; December 21, 1903, to January 1, 1912, superintendent Cleveland & Pittsburgh division, same company. January 1, 1912, he was appointed general superintendent, central system, of the Pennsylvania Lines West, which position he held until his appointment noted above.

Engineering

E. M. DURHAM has been appointed special engineer of the *Atlanta, Birmingham & Atlantic R. R.* at Atlanta, Ga., as announced in our February issue. He graduated from Lehigh University in 1896, and was employed in Government service till 1898, when he entered railway work as transitman on the C. & N. W. Ry. He was appointed assistant engineer on the Southern Ry. in 1900, and resident engineer in 1901. He was promoted to principal assistant engineer in the construction department, office at Birmingham, Ala., which position he resigned February 1 to take the appointment mentioned above.

C. J. CHENOWETH has been appointed engineer of roadway of *Atlantic Coast Line R. R.* at Savannah, Ga., succeeding O. T. Waring, promoted.

J. E. BEATTY has been appointed division engineer of the *Canadian Pacific Ry.* at Montreal, Que. C. T. DE LAMERE has been appointed assistant engineer of construction at Montreal, Que.

C. W. JOHNS, formerly engineer maintenance of way, has been appointed engineer of branch lines of the *Chesapeake & Ohio Ry.*, office at Richmond, Va., succeeding R. B. Burks.

D. ROUNSEVILLE has been appointed engineer maintenance of way of the *Chicago & North Western Ry.*, lines east, as noted in our February issue. He was born at Sheboygan Falls, Wis., October 29, 1856, and was educated in the public and private schools. He began railway work as chainman on location for the Milwaukee, Lake Shore & Western Ry. April 1, 1879, and one year later was appointed instrument man on the St. Paul & Eastern Grand Trunk Ry. He entered the service of the M., L. S. & W. Ry. September 1, 1880, as assistant engineer, and later was appointed location and construction engineer. He returned to the Milwaukee, Lake Shore & Western Ry. as division engineer in 1885, and was appointed assistant engineer of the C. & N. W. Ry. in 1895, and division engineer September 20, 1897. He was resident engineer in charge of the construction of the Green Bay & North Western Ry. March 22, 1906, to April 1, 1907, and then returned to the Ashland division as division engineer. He was resident engineer in charge of the construction of the Milwaukee, Sparta & North Western Ry. from March, 1909, to March, 1912, and resident engineer in charge of the construction of the St. Louis, Peoria & North Western Ry. from March, 1912, to February 1, 1914, on which date he was appointed engineer maintenance of way as above noted.

As noted in our February issue, R. W. WILLIS has been appointed engineer of the Illinois district of the *Chicago, Burlington & Quincy R. R.*, office at Chicago, Ill. He graduated from Virginia

Military Academy in 1895, and entered the service of the Chicago, Burlington & Quincy R. R. as rodman April 8, 1898. August 1, 1902, to April 1, 1903, he was assistant to chief engineer of the Cincinnati Northern R. R., and reentered service of the C., B. & Q. R. R. April, 1903, as assistant engineer, and was employed mostly on construction work. January 1, 1905, he was appointed division engineer at Galesburg, Ill., and March 11, 1907, was appointed engineer Missouri district at St. Louis, Mo., which position he held till his recent appointment, noted above.

As noted in our February issue, A. L. JOHNSTONE has been appointed assistant engineer maintenance of way of the *Cleveland, Cincinnati, Chicago & St. Louis Ry.* at Wabash, Ind. He started working for the C., C., C. & St. L. Ry. in September, 1909, after leaving the University of Illinois, and was employed as rodman and, later, instrumentman on the St. Louis division at Mattoon, up to the first of the year, when he was transferred and given the position of assistant engineer maintenance of way, as noted above.

W. A. HUNICKE has been appointed assistant engineer of the *Missouri Pacific Ry.*, at St. Louis, Mo.

C. W. BACKE has been appointed chief engineer of the *Nevada Northern Ry.*, office at East Ely, Nev.

W. S. HANLEY, formerly division engineer, has been promoted to chief engineer of the *New Orleans & Great Northern R. R.* at Bogalusa, La., succeeding C. R. Howard.

CHARLES S. CHURCHILL has been appointed assistant to the president of the *Norfolk & Western Ry.*, in charge of valuation, office at Roanoke, Va. From 1879 to 1881 he was engaged in railway surveys and construction in Connecticut and Pennsylvania, in the latter State constructing what is now a portion of the Bessemer & Lake Erie R. R. In 1881 he was appointed division engineer of construction of the Pittsburgh & Lake Erie R. R., and in 1884 principal assistant engineer on construction of the Schuylkill division of the Pennsylvania R. R. He was appointed engineer maintenance of way of the Shenandoah Valley R. R. in 1887 (now a part of the N. & W. Ry.). In 1888 he was appointed engineer maintenance of way of the Norfolk & Western Ry., and since 1903 has been chief engineer. He has filled terms of vice president and director of the American Society of Civil Engineers, is a member of the Institution of Civil Engineers, a member of advisory committee of the American Society for Testing Materials, and last March completed a term as president of the American Railway Engineering Association.

C. E. APPLE, Supervisor B. & B.
San Antonio & Aransas Pass Ry.

T. E. SMITH, Supervisor B. & B.
Southern Ry.

T. F. LAIST, Architect
U. S. Valuation

C. W. BURNS has been appointed division engineer of the *Corvalis & Eastern R. R.* at Albany, Ore.

W. W. DRINKER, formerly engineer of terminal improvements, has been promoted to principal assistant engineer of the *Erie R. R.*, office at New York, N. Y. F. S. WHEELER, formerly roadmaster, has been promoted to division engineer, at Buffalo, N. Y.

As announced in our February issue, D. W. SMITH has been appointed valuation engineer of the *Hocking Valley Ry.*, office at Columbus, O. He graduated in civil engineering from the Ohio State University in 1899, and was rodman and instrumentman on the H. V. Ry. from that date till 1903, when he was appointed assistant engineer. In 1907 he was appointed division engineer, and in 1911 construction engineer, holding the latter position till his appointment as valuation engineer, noted above.

J. K. CONNER has been appointed chief engineer of the *Lake Erie & Western R. R.*, office at Indianapolis, Ind., succeeding J. A. Atwood, resigned to enter valuation work for the Interstate Commerce Commission. Mr. Conner was employed on county and municipal work in 1891. In 1895 he went with the C., C., C. & St. L. Ry. as assistant engineer, and later served as supervisor of track till 1899, when he entered the service of the B. & O. S.-W. R. R. as assistant engineer. He was appointed assistant engineer on the N. Y. C. & H. R. R. R. in 1900, and in 1901 was appointed bridge draftsman and designer on the L. S. & M. S. Ry., remaining in this position until 1903, when he was appointed resident engineer on the L. E. & W. Ry. He was appointed assistant engineer in 1905, and first assistant engineer in 1906, which position he held till his recent appointment, noted above.

J. E. CRAWFORD has been appointed chief engineer of the *Norfolk & Western Ry.*, office at Roanoke, Va. He graduated from the University of Pennsylvania in 1895 and was employed as a draftsman by the Pencoyd Iron Works. In 1898 he was promoted to designer, and in 1903 was appointed acting bridge engineer of the N. &. W. In 1904 he was appointed bridge engineer, and in 1913 was promoted to acting chief engineer, at which time C. S. Churchill, chief engineer, was placed in charge of valuation work. Mr. Crawford's appointment as chief engineer was effective March 1.

G. R. BARRY, formerly division engineer at Logansport, Ind., has been appointed division engineer of the *Pennsylvania Lines West* at Columbus, O. W. E. GUIGNAN, formerly assistant engineer, has been promoted to division engineer at Zanesville, O. He succeeds A. C. WATSON, appointed division engineer at Logansport, Ind., succeeding Mr. Barry. F. H. WATTS, formerly at Columbus, O., has been appointed division engineer at Pittsburgh, Pa., succeeding G. Le Boutillier, promoted.

CLARK DILLENBECK, formerly assistant engineer, has been appointed engineer of bridges of the *Philadelphia & Reading Ry.*,

office at Philadelphia, Pa. OTTO HEROLD has been appointed assistant engineer at Philadelphia, Pa., succeeding Mr. Dillenbeck.

J. C. AUTEN, formerly division engineer, has been promoted to principal assistant engineer of the *Philadelphia, Baltimore & Washington R. R.*, at Wilmington, Del., succeeding C. I. Leiper. J. R. MCGRAW, formerly division engineer of the Buffalo division, has been appointed division engineer at Wilmington, Del., succeeding Mr. Auten.

A. MAGUIRE has been appointed chief engineer of the *San Pedro, Los Angeles & Salt Lake R. R.*, office at Los Angeles, Cal., succeeding E. G. Tilton.

H. W. RODENBAUGH, formerly assistant engineer, has been promoted to supervising engineer of the *Southern Ry.*, at Washington, D. C.

The titles of H. B. TITCOMB, Los Angeles, Cal., and R. M. DRAKE, San Francisco, Cal., formerly district engineers, have been changed to maintenance of way assistants, *Southern Pacific Co.*

H. F. Schryver, formerly assistant engineer, has been appointed valuation engineer of the *Toledo & Ohio Central R. R.*, office at Columbus, O.

Bridges and Buildings

F. M. GRIFFITH, formerly supervisor of bridges and buildings, has been appointed superintendent of joint track, bridges and buildings and water supply, *Chesapeake & Ohio Ry.*, office at Covington, Ky. J. E. KING has been appointed supervisor of bridges and buildings at Huntington, W. Va.

J. ORCUTT has been appointed master carpenter of *Erie R. R.* at Huntington, Ind., succeeding N. McLean.

C. E. APPLE, formerly engineer in the maintenance of way department, has been appointed supervisor of bridges and buildings of the *San Antonio & Aransas Pass Ry.*, at Yoakum, Tex., succeeding B. F. Whiting, resigned on account of ill health.

T. E. SMITH, formerly bridge foreman, has been appointed supervisor of bridges and buildings of the *Southern Ry.* at Sheffield, Ala., succeeding P. S. Shelton.

U. S. Valuation

WILLIAM G. ATWOOD, formerly chief engineer of the Lake Erie & Western Ry., has been appointed assistant district engineer of the *U. S. Board of Valuation Engineers* at Chattanooga, Tenn. He was born in 1872 at Fredonia, N. Y., graduated from Cornell University in 1892, and engaged in municipal work in Chicago. From 1897 to 1902 he was mining engineer and U. S. deputy surveyor in Alaska, and was locating engineer and later superintendent of construction on the Alaska Central Ry., 1902 to 1904, on the later date being appointed assistant engineer of construction. In 1907 he went to work with the L. S. & M. S. Ry. as division engineer, and in 1909 was appointed chief engineer of the L. E. & W. Ry., his appointment on U. S. valuation being effective February 1.

B. J. DALTON has been appointed assistant district engineer at Kansas City, Mo. He was employed as a rodman on the Missouri-Pacific Ry. in 1887, and after attending the University of Kansas was re-employed as transitman. He was promoted to assistant engineer in charge of heavy mountain construction and was then appointed resident engineer, Texas-Louisiana & Eastern Ry. in February, 1891. In 1894 he engaged in private practice, and in 1895 was appointed division engineer of construction on the K. C., P. & G. Ry. In 1898 he was appointed chief engineer of the Kansas, Oklahoma Central & South Western Ry. and in 1900 was appointed locating engineer, and later assistant chief engineer of the St. Louis & N. O. Ry. From 1903 to 1905 he was city engineer Lawrence, Kan., and in 1905 was appointed chief engineer of the D. E. & G. Ry. and the D. K. & G. Ry. In 1906 he became associate professor of civil engineering at the University of Kansas, and held the position of professor of civil engineering at the time of his recent appointment noted above.

T. F. LAIST has been appointed chief of the architectural department of the central district, with headquarters in Chicago. Mr. Laist graduated from Cornell University in 1888 and afterward studied in Europe. From 1897 to 1902 he was senior draftsman in the office of the supervising architect of the Treasury Department at Washington, and also professor of architecture in Columbian University, Washington. Between 1903 and 1905 Mr. Laist was Federal superintendent of public buildings He became asociated with the firm of Holabird & Roche in 1910 and held the position of assistant superintendent at the time of his appointment noted above.

As noted in our February issue, F. B. SCHEETZ has been appointed engineer in charge of the structural department of the western district. Mr. Scheetz was born in 1867 at Monroe City, Mo. He took the first three years of the civil engineering course in the State University of Missouri, leaving there in 1887 to begin railroad service in a location party of the St. Louis & San Francisco R. R. in Indian Territory. In 1888 he became rodman and levelman on the Kansas City, El Paso & Northeastern, going to the Missouri Pacific in 1889 as rodman. In 1890 and 1891 he was transitman on the construction of drawbridges over the Arkansas river, and in 1892 was engineer in charge of the construction of a drawbridge over the Little river in Louisiana. In the latter part of this year he left the Missouri-Pacific and took charge of construction on the Missouri division of the Missouri, Kansas & Texas. From 1893 to 1896, he was engaged in maintenance work on the St. Louis, Iron Mountain & Southern, going, in the spring of 1896, to the bridge and building department of the Missouri Pacific and the St. Louis, Iron Mountain & Southern. From 1896 to 1905 he was assistant engineer of bridges and buildings. He was appointed engineer of bridges and buildings of the Missouri Pacific Ry. in 1905, and went with the Kansas City Bridge Co. in 1910. His recent appointment, noted above, was effective February 1.

As noted in our February issue, C. B. SPENCER has been appointed senior civil engineer of the track and road department of the western district of valuation. Mr. Spencer is a graduate from the high school of Joplin, Mo., of the engineering department of the State University at Rolla, Mo., and the engineering department of Cornell University, Ithaca, N. Y., and began his railroad experience in 1894. He has been with the Kansas City, Fort Scott & Memphis R. R., and the St. Louis & San Francisco R. R., filling the positions of rodman, assistant engineer, resident engineer, division engineer, district engineer and office engineer. He resigned from this last position to take up his new work.

M. P. PARET has been appointed assistant district engineer at San Francisco, Cal.

Signal

As noted in our February issue, F. G. WHITE has been appointed signal engineer of the *Chicago Great Western R. R.*, office at Chicago. He was educated in the public schools of Waterloo, Wis., and graduated in the electrical course at the University of Wisconsin in June, 1905. He entered railway work as signal repairman for the Pennsylvania Lines West of Pittsburgh at Chicago on July 5, 1905. August 1, 1906, he was transferred to the Eastern division of the Pittsburgh, Ft. Wayne & Chicago in the same capacity, with headquarters at Rochester, Pa. In the spring of 1907 he was transferred to the Alliance, O., district as assistant foreman on construction work, and May 1, 1908, was transferred to the office of the signal engineer at Pittsburgh as draftsman. May 15, 1899, he resigned to become draftsman and designer for the Northern Pacific Ry. signal department at St. Paul. He resigned this position August 20th of the same year to become signal supervisor for the Chicago Great Western R. R. at St. Paul. In March of 1910 he was appointed assistant special signal engineer of construction for the Chicago Great Western R. R., with headquarters at Chicago. Following the death of Mr. William Daves, special signal engineer, in August of that year, he was appointed assistant signal engineer, and resigned July 1, 1912, to become valuation signal engineer for Mr. M. A. Zook, consulting engineer of Chicago and New York. October 1, 1912, he completed valuation work on the Canadian Pacific Ry., and November 9, 1912, accepted a position as signal inspector for the Great

Northern Ry. at St. Paul, which position he held until his appointment as signal engineer of the Chicago Great Western R. R., as noted above.

J. H. Ross has been appointed supervisor of signals and interlocking of the *Cleveland, Cincinnati, Chicago & St. Louis Ry.* at Springfield, O. He succeeds J. F. Williams, who has been appointed supervisor of signals and interlocking at Galion, O., succeeding D. M. Clay.

R. G. Gage has been appointed signal and electrical engineer of the *Intercolonial Ry.*, office at Moncton, N. B.

F. H. Buchanan has been appointed signal engineer of the *Pennsylvania Lines West*, office at Pittsburgh, Pa. He was born in Warren county, Pennsylvania, March 3, 1868. His signal experience covers a period of twenty-six years, seventeen of which have been with the Pennsylvania Lines West of Pittsburgh as signal foreman, supervisor and inspector.

John King has been appointed supervisor of track of the *Cincinnati, New Orleans & Texas Pacific Ry.* at Dayton, Tenn., succeeding M. Davis. B. Carrell has been appointed supervisor of track at Stearns, Ky., succeeding J. G. Spradlin.

W. H. Mayer has been appointed supervisor of track of the *Cleveland, Cincinnati, Chicago & St. Louis Ry.* at Union City, Ind., succeeding S. A. Mackey.

P. Quinlan has been appointed acting roadmaster of the *Delaware, Lackawanna & Western R. R.* at Buffalo, N. Y., succeeding T. H. Powers.

A. Burgett has been reappointed supervisor of track of the *Erie R. R.* at Huntington, Ind., succeeding W. Krichbaum. He has been superintendent of construction for about a year and a half. C. Hyland Jones, formerly resident engineer, has been appointed supervisor of track at Deposit, N. Y., succeeding F. S. Wheeler, promoted. W. Murtaugh has been appointed supervisor of track at Decatur, Ind. P. J. Nolan has been appointed supervisor of track at Hammond, Ind., succeeding J. Dalton. J. Pierson, formerly superintendent of construction, has been appointed supervisor of track at Meadville, Pa., succeeding William Groover.

W. McGar, supervisor of track of the *Grand Trunk Ry.*, has been transferred from Stratford to Brantford, Ont. He entered the service of this railway in 1874 as trackman and was promoted to roadmaster in 1898. A rearrangement of territory resulted in his transfer. C. O'Dell, supervisor of track, has been transferred from Toronto to Hamilton, Ont. L. Pender, supervisor of track, has had his headquarters moved from Wingham to Palmerston, Ont. The office of A. Warren, supervisor of track, has been moved from Woodstock to London, Ont. T. Wilson has been appointed supervisor of track at Allandale, Ont.

N. Johnson, assistant roadmaster of the *Great Northern Ry.*, has been transferred from Great Falls to Conrad, Mont. A. Newberg has been appointed assistant roadmaster at Morris, Minn., succeeding C. Hara.

F. R. Bishop has been appointed supervisor of the *Illinois Central R. R.* at Leland, Miss., succeeding W. A. Becker. J. W. Coffey has been appointed supervisor at Pana, Ill., succeeding J. O'Brien, transferred. W. E. McCune has been appointed supervisor at Durant, Miss., succeeding R. L. Webb. John O'Brien, supervisor, has been transferred to Clinton, Ill. J. L. Piper, formerly instrumentman, has been appointed supervisor at Newton, Ill., succeeding G. E. Surrells, retired on account of poor health. J. Pruitt has been appointed supervisor at Central City, Ky.

William Rotroff has been appointed roadmaster of the *Lake*

F. G. WHITE, Signal Engineer
Chicago Great Western R. R.

H. A. METCALF, Roadmaster
Alabama Great Southern R. R.

E. A. GILES, Roadmaster
Atlantic Coast Line R. R.

Maintenance of Way

H. E. Metcalf has been appointed roadmaster of the *Alabama-Great Southern R. R.*, office at Birmingham, Ala., succeeding W. J. Edwards, promoted to superintendent.

J. H. Tate, roadmaster of the *Atchison, Topeka & Santa Fe Ry.*, has had his main office transferred to Vaughn, N. M., retaining a sub-office at Clovis, N. M

E. A. Giles, formerly rail gang foreman, has been promoted to roadmaster of the *Atlantic Cost Line R. R.* at Climax, Ga., succeeding Charles Schmidt.

J. Hallonquist, roadmaster on the Saskatchewan division, *Canadian Pacific Ry.*, has been transferred from Moose Jaw to Regina, Sask. J. Jelly, roadmaster on the Eastern division, has been transferred from Ottawa to Smiths Falls, Ont. A. J. Megrund has been appointed roadmaster of the Manitoba division at Winnipeg, Man., succeeding T. M. Fraser. R. C. Montgomery, roadmaster on the Eastern division, has been transferred from Ottawa to Smiths Falls, Ont. J. Walsh, roadmaster, has been transferred from Smiths Falls, Ont., to Farnham, Que.

W. O. Dunn, formerly section foreman, has been promoted to supervisor of the *Central of Georgia Ry.* at Macon, Ga., succeeding C. B. Yancy. J. C. Pace, supervisor, has been transferred from Carrollton to Cedarton, Ga.

W. Bibby has been appointed roadmaster of the *Central Vermont Ry.* at St. Albans, Vt., succeeding A. Bosley.

M. Regan, supervisor of track of the *Chesapeake & Ohio Ry.*, has been transferred from Covington, to Maysville, Ky., following a rearrangement of districts.

Erie & Western R. R. at Akron, O., succeeding D. P. Beatty.

D. CUNNINGHAM, roadmaster of the *Michigan Central R. R.*, has been transferred from Lapeer to Jackson, Mich.

THOMAS ESKRIDGE has been appointed supervisor of the *Missouri & North Arkansas R. R.* at Harrison, Ark., succeeding D. P. Cunningham.

M. L. STAGE has been appointed roadmaster of the *Missouri Pacific Ry.* at Helena, Ark., succeeding L. C. Levee.

J. J. BRIDGES has been appointed roadmaster of *Morgan's Louisiana & Texas R. R.* at Lafayette, La. He succeeds G. M. DUGGER, who has been appointed roadmaster at New Iberia, La., succeeding A. Wehmer. W. L. HESTERLY has been appointed roadmaster at Morgan City, La.

H. EASLEY has been appointed assistant roadmaster of the *St. Louis South Western Ry.* at Hamilton, Tex. He has held positions as section and extra gang foreman, clerk to supervisor, clerk to master carpenter, division accountant, chief clerk to division engineer, assistant chief clerk to division superintendent and assistant supervisor, in the latter position having charge of interstate accounting.

C. C. WARREN has been appointed assistant roadmaster of the *St. Louis South Western Ry.* at Tyler, Tex., succeeding Ed Arnold.

R. M. MCNALL, formerly engineer of the *San Antonio & Aransas Pass Ry.*, on the Waco division, has been appointed roadmaster at Yoakum, Tex., succeeding T. E. Garrett.

G. L. SITTON, formerly assistant roadmaster, has been promoted to roadmaster of the *Southern Ry.* at Charleston, S. C., succeeding W. H. Martin.

L. H. MITCHELL has been appointed superintendent of roadway of the *Union Traction Co. of Indiana*, office at Anderson, Ind.

G. C. LOVELL, formerly track inspector, has been appointed supervisor of the *Wabash R. R.* at Brunswick, Mo., succeeding J. H. Jackson. JOHN ORMAN, formerly section foreman, has been promoted to supervisor at Bement, Ill. FRANK SANNER has been appointed supervisor at Bluffs, Ill., succeeding T. W. Wagner.

With The Manufacturers

SOME INTERESTING EXHIBITS.

Brief descriptions are given herein of the articles to be exhibited by a number of firms at the Railway Appliances Show at the Coliseum, Chicago, March 17, 18, 19 and 20.

The educational value of these exhibits is too well recognized to require comment, and the growing interest in them shows that railway officials are coming to regard these exhibits as an opportunity to obtain valuable information with regard to necessary track appliances and appurtenances.

THE AMERICAN VALVE & METER CO. will exhibit two types of interlocking switch stands, one fitted with a semaphore blade, the other with a target. In these stands the target or semaphore and the interlocking mechanism are operated by the same lever which throws the switch.

The mechanism will not interlock unless the switch point is properly closed, and when not interlocked the target or semaphore shows "danger." When the switch is closed properly the mechanism interlocks and the semaphore or target shows "clear."

The interlock is provided with a plunger bar which prevents the switch opening should the stand be destroyed or disconnected from the switch under traffic.

The switch stand is designed so that it can be used without the interlocking or other special safety features, and these features may be added later if desired.

* * * *

S. F. BOWSER & CO. will exhibit a general line of oil storage and distributing devices, including the special railroad table tank and a five-gallon oil pump. The accurate self-measuring features of these different devices will be demonstrated to visitors, as well as the economy, safety, convenience and compactness of the different equipments.

The five-gallon pump is a new design recently placed on the market. It effects a saving of time, as it discharges five gallons of oil on a single, full upward stroke of the plunger. The plunger is then returned to its former position by one and one-half turns of the handle, so that the action is very rapid. This equipment is for handling gasoline or any oil that can be pumped.

* * * *

THE L. S. BRACH SUPPLY CO. will exhibit the Brach automatic flagman, which is an audible and visible signal for highway crossings. It may be operated in the same source of current that the present crossing bells are now using, and in the same manner of control, or by special contacts, which are furnished. It gives a powerful swinging red light, which represents a swinging red lantern, implying danger, as well as ringing an 18-inch locomotive type bell, together with a suitable sign. It has no moving parts exposed and has its main elements built in accordance with a practice adopted by the Railway Signal Association. The lamps are all in multiple, so that it would require the failure of eight lamps before all indication would be lost.

* * * *

THE BUDA CO.'S exhibit will consist principally of motor cars for inspection and section use, motor velocipedes for roadmasters and signal maintainers, ball bearing jacks for locomotives, bridge and general service, ball bearing and cone bearing journal jacks, ratchet track and car jacks, electric crossing gate in operation, Buda patented all steel bumping post for freight and passenger service, electric storage battery shop and freight house truck, gasoline motors, "Hyduty" new style Paulus track drill and bonding drill, Buda portable carborundum tool grinder, switch stands, etc.

Special features claimed are the superiority of the four-cycle engine, the simplicity of the friction transmission and positive oiling system on Buda motor cars, the Buda patented positive stop on ball bearing and cone bearing jacks, bumping posts that do not require any excavation for foundation or dead-man, special demonstration of a successful electric crossing gate, and an improved electric storage battery truck.

* * * *

THE CARNEGIE STEEL CO. will exhibit a new steel cross-tie, the first of which were put into service in 1913. A 30-foot section of track complete will be installed. There will also be exhibited the "Braddock" insulated joint, the Duquesne rail joint, and some steel sheet piling.

* * * *

THE CHICAGO BRIDGE & IRON WORKS will exhibit all steel railway service tanks. The elliptical bottom tank was originated by this company and this type of tank is the only one which does not require an expansion joint.

These tanks have a special feature of a large riser pipe which acts as a settling basin for sediment, and the makers will be prepared to demonstrate with a model how the sediment settles down to the extreme bottom of the large riser pipe, where it is easily removed through a special washout valve. This leaves the clear water in the upper part of the tank to be drawn off for service. These steel tanks are in use on more than ninety of the leading railroads in the United States and Canada.

* * * *

THE CONLEY FROG & SWITCH CO. will exhibit a line of frogs of ordinary Bessemer or open hearth steel, or frogs with manganese inserts, or of solid manganese of the Stag brand.

The distinctive feature of the Conley frogs is a construction which eliminates the necessity for guard rails. This construction consists of raised rails bolted to the outside of running rails and wings so that the wheel is guided through the frog by

contact with the tread rim. The advantage of this construction is very apparent and the makers claim the savings are very marked. In the cost of the first installation there is an elimination of the two guard rails, together with the cost of handling, setting into place and spiking. The cost of maintenance of a guard rail is a more objectionable feature, as all trackmen know the difficulty of keeping a guard rail spiked up and in place, especially under heavy traffic with frogs of short radius lead.

The first Conley frog was made in 1905, and the use of this frog has become general on a number of railways, which have found it to be economical and efficient. The reader will be interested in the many variations of this distinctive type of frog, which will be exhibited at the Maintenance of Way Show.

* * * *

THE DETROIT GRAPHITE CO. will exhibit paints for bridges and buildings and for general railway use. This company claims close attention to detail and resulting excellence of manufacture. The bridge paint is a graphite paint made with graphite from the company's own mine.

Samples of graphite and paint will be on exhibit. Data will be presented showing the durability, and the economy resulting from the great spreading capacity of these paints.

* * * *

THOMAS A. EDISON, INC., will exhibit Edison B S C O primary batteries. The makers state that these batteries are peculiarly suited for electric semaphore service and automatic signal work in general, owing to ability to deliver discharges as high as three amperes constantly; and for track circuit work on account of long life and the fact that the very uniform voltage of the cell allows regulation with external resistance, so that loss or waste is reduced to the minimum when a train is occupying the section; and for telephone transmitters, on account of there being no loss of energy when the circuit is open and the cells standing idle.

The improvements in construction will be demonstrated, as well as the reliability and economy as compared with gravity battery and other high internal resistance cells for track circuits, and the progressive development which has been and is now being made in the cell, resulting in marked economy.

* * * *

THE GORDON PRIMARY BATTERY CO. will exhibit the new type R. S. A. Gordon cells designed especially for motor signal work; also crossing bells and general primary battery requirements. The Waterbury track cell will also be exhibited.

The Gordon R. S. A. cell, the makers state, has been greatly improved by a rearrangement of the elements and by a new departure in the handling and treating of materials to maintain the voltage under heavy discharge.

The Waterbury track battery is a high internal resistance cell for track circuit work. The special feature of this cell is the provision for maintaining the elements equi-distant at all times during exhaustion, providing for uniform internal resistance. The distinctive construction features make the battery easy to set up and recharge.

* * * *

THE HAGGARD & MARCUSSON CO. will exhibit Tiger steel bunks. This bunk is light, strong and sanitary. It has steel springs and is much more comfortable than a wooden bunk. Its cost is no greater than that of building a wooden bunk, tearing it down and rebuilding it once. It is easily assembled or dismantled and can be shipped flat.

* * * *

THE HAYES TRACK APPLIANCE CO. will exhibit Hayes derails. This device is the only two-piece derail made, it does not break the track, and is practically unaffected by ice and snow. It gives the maximum car capacity, as it can be located at the point of clearance, and is not affected by creeping rail and will fit several rail sections.

The makers state that there are more than 75,000 derails in use in all parts of the world, which demonstrates the popularity of the device for use under all conditions. They are prepared to demonstrate the advisability of equipping a sidetrack with a Hayes derail, irrespective of grade.

* * * *

HUBBARD & CO. will exhibit track tools and track shovels. Both shovels and track tools are usually made under the specifications of the railways, but in addition the makers state that a proper interpretation of these specifications and a thorough knowledge of steel are necessary to meet the rigorous requirements for these tools. The number of years' experience of this firm and the wide use of their tools justifies the claim that these tools are beyond the experimental stage.

A new plant is being built in Pittsburgh that will have about two and one-half times the present capacity in this line, and this plant is to be equipped with all the modern appliances for hardening and finishing, which is a large factor in the manufacturing of these tools.

The different grades of steel used for the different track tools are carefully selected with a view of producing the best article it is possible to make for the purpose required.

* * * *

The INTERNATIONAL HARVESTER CO. OF AMERICA will exhibit the Booster hand car engine.

This engine is a two-cycle, 3 H. P., hopper-cooled engine, with a hit-and-miss governor, which cuts off both fuel and spark when the engine attains full speed. In the manufacture of this engine the makers state that every provision has been made to insure steady running, ease of operation, simplicity of application, freedom from accident and positive economy. It is light in weight and easily operated.

The engine is mounted on a wooden base, ready to install. Belt drive is used, with a belt take up (an exclusive feature) that can be adjusted by simply moving one bolt. The engine slides on its base, and can be moved forward and backward by means of a lever.

* * *

The KALAMAZOO RAILWAY SUPPLY CO. will exhibit a general line of railway supplies, including hand, push, velocipede and track laying cars, motor cars, track drills, track jacks, track gauges, levels, etc.

The special applications and improvements of these tools will be demonstrated, as well as the general dependability shown by these appliances in service.

* * *

THE C. F. MASSEY CO. will exhibit a small model of a reinforced concrete trestle which is fireproof, non-corrosive, can be installed economically, and, it is claimed, will practically last forever.

Some features of this design are the simplicity of construction, adequate provisions for retaining ballast, the method of draining the ballast, and the improvement in architectural appearance which is obtained by paneling.

It is claimed that the adoption of this design of trestle will minimize the labor cost of construction and maintenance, and prevent the disturbances to traffic which are necessitated by frequent renewal of non-permanent structures.

* * * *

MUDGE & CO. will exhibit five models of inspection cars, as follows: (1) Class EI, 4 H. P. car with a capacity of three men and tools; (2) class EEI, 8 H. P., front drive, two cylinders, with high power and ability to climb steep grades; (3) class EOI, 4 H. P. car, weighing 275 lbs., designed for one man but with capacity for two; (4) class EESF, the safety first car, 8 H. P., underslung frame, with ample capacity for four men, and especially designed for long inspection trips; (5) class GI, identical with class EI, with the exception that it develops 6 H. P.

Other appliances to be exhibited are class FS and FH cars, which are general utility cars. The FS model has a long centerboard, and the FH car has handle bars which are locked out of service while motor is operating. Class CQ is a 6 H. P. engine for application to hand cars, shipped entirely assembled, and easily applied.

THE NATIONAL STANDARD CO. will exhibit a general line of track tools, grinders and drills, but the principal article to be exhibited will be Cook's bonding drill.

It is claimed that this bonding drill won't jump, stick and break drills just as the hole is finished. It is the only machine which permits the withdrawal of the bit at any time without reversing the direction of the handle or without risk of breaking the drill.

The frame is of rigid malleable iron and gives constant and true alignment. The frame itself does not move; the spindle travels backward and forward on its own bearings. All wearing parts are thoroughly hardened, including sprockets, pinions and threads. Oil-tight casings keep the mechanism always lubricated and free from sand and dirt. Roller bearings reduce friction to a minimum.

* * * *

GEO. P. NICHOLS & BRO. will exhibit as heretofore, a standard electric turntable tractor, changed but little from last year. The year 1913 brought repeated evidence the company states, of the satisfactory service that these tractors have been giving and a larger number of orders than ever before, due to the reliability of the apparatus, its completeness in every detail, and the satisfactory service given customers, which the manufacturers are prepared to explain and demonstrate.

* * *

THE OKONITE CO. of New York City and their general western agents, the CENTRAL ELECTRIC CO. of Chicago, will be pleased to have signal men make booth 16 their meeting place during the exhibit at the Coliseum, March 16th to 20th inclusive, where will be exhibited and demonstrated the high quality of Okonite insulated wires and cables. The Central Electric Co. carries in stock thousands of feet of Okonite insulated wires and cables, and extends an invitation to all signal men, and others attending the convention, to visit the general office and storerooms, 320-326 So. Fifth avenue.

* * *

THE PHILLIP CAREY CO. will exhibit Carey Flexible Cement Roofing, which the makers state is scientifically designed to produce a monolithic roof when applied. A special patented lap will be demonstrated, which is inverted down over the nail heads, protecting them from rust, at the same time eliminating joints and making the roof practically one unbroken surface. The life of the roof lies in the solid flexible cement body, which is held in bond, and thoroughly protected by the heavy saturated felt base, and a heavy Calcutta burlap embedded in the surface, which in turn is thoroughly coated with a special grade of asphalt. The patent lap extends over one sheet on to the next, thoroughly covering the nail heads, and a coating of Manco asphalt cement is mopped over the entire surface of the roof after application, thus sealing all joints as well as the body of the roof to assure durability and permanency.

* * *

The PITTSBURGH-DES MOINES STEEL CO. (formerly the Des Moines Bridge & Iron Co.) will exhibit steel water tanks, standpipes, coaling stations, oil tanks and structural materials. Photographs, circulars and catalogues will be on hand, which the representatives will be glad to talk over with interested parties.

* * *

THE POSITIVE RAIL ANCHOR CO. will exhibit the Positive rail anchor and the Betts one-piece anti-creeper tie plate.

The special characteristic of this anchor is that it is one-piece, and it is the only one of its kind on the market. Simplicity in handling, elimination of the danger of lost parts and ease of application are the claims made for this device.

The method of application and removal as well as the principles underlying the design of this device will be demonstrated to those visiting the booth.

* * *

THE RAMAPO IRON WORKS will exhibit Ramapo automatic safety switch stands, rolled shoulder switch slide plates, manganese center frogs, manganese reinforced switch points, manganese rolled rail frogs and guard rail clamps.

The automatic safety switch stands exhibited are the latest improved patterns. The solid rolled switch slide plates fill a long-needed requirement in providing a solid plate with riser and shoulders rolled on same; the shoulders being absolutely square for holding stock rail and rail braces in place. The shoulder against base of stock rail under the rail brace holds switches accurately to gauge.

Manganese reinforced switch points are coming into very universal service for busy switches, and the makers guarantee their manganese reinforcing to make the point end of switch last approximately as long as the heel end.

* * * *

The RICHARDS-WILCOX MFG. CO. will exhibit working models of parallel door equipment, vertical doors, fire door fixtures, power grindstones and ball-bearing hangers for sliding doors, of every description.

This company has gone into the design and manufacture of the above articles very completely and is prepared to furnish door hangers of every description. This company's exhaustive study of the subject places it in an excellent position to give expert demonstration of the articles to be exhibited, and advice as to the devices to be used under ordinary or special conditions.

BEALL TOOLS.

The growth and development of many enterprises is attributable to their geographical situation, the timeliness of their inception or the natural or unnatural monoply of their products.

Certain manufacturers have risen into prominence because of adherence to a strictly-set standard of quality. There formerly existed a type of old fashioned manufacturers which took pride in the fact that their name and individuality was never associated except with products of the highest quality. These masters of their crafts and disciples of the "Old School" scorned to put into their product anything but the best in both brains, raw material and workmanship. They were men with a conscience and they operated business with a conscience and their product had a conscience hammered into its fiber.

Many years ago in a little town in the southernmost part of Illinois, two brothers forged picks and tools over the anvil in what was scarcely larger than the proverbial "Village Smithy." They sold their output to the surrounding mines of the central coal fields, in a day when men grubbed coal from "Old Mother Nature's Bowels" with the pick and powder keg. Every blow of a sledge on hot iron was directed by a purpose and into every implement forged by these pioneers they wrought something of their own fiber. They maintained their standards together with their self-respect and gradually won for themselves and for their tools a reputation which became an asset of much worth.

Times, methods and commercial conditions have changed. From a little forge shop has grown a series of splendid modern manufacturing plants. Modern machinery to a great extent has replaced the old methods of coal mining. The output of this institution now covers a wide range and variety of tools, and its product is used by industrial corporations of every character. Their factories cover many acres. The din of their industry disturbs the peace of several communities, but one original feature, one prime factor still remains.

It has been said that every business has personal character and that its character invariably reflects the traits and peculiarities of the men who are responsible for its success or failure. This pair of sturdy old "Smiths" imbedded deep into the character of the business which they founded a respect for quality and efficiency which has endured and passed on to those who follow. Their sons do not wield the sledge nor tongs, but the pride of the craftsmen still exists in the business of Beall Brothers, and though a ponderous and mighty machine replaces the slow hand forging of the "Early Eighties" the art of blacksmithing still is exemplified at its best in their shops.

Modern methods of analysis, test and inspection have replaced

the laborious efforts of crude tempering and hardening. Modern science has determined what particular kind of steel shall be used in each individual tool. Service tests of the most severe character back up the specification of engineer and metallurgist, yet back of all this there still endures the desire of the master craftsman to excel in his art, hence the watchword "quality" is the slogan of this business.

Quality is, indeed, more than a slogan or a watchword with Beall Bros. It is an ingrained sentiment, inherited with the business itself by those who now administer to its success.

The two old pioneers who founded this institution builded more wisely than they knew, for they laid the foundations of a perpetual monument to "quality."

AN OLD TIME TRANSIT.

The accompanying illustration shows Transit No. 1, manufactured by Brandis & Sons Mfg. Co., Brooklyn, N. Y. This instrument was made in 1873 and sold to the Ontario & Western.

It is stated that the instrument is still in use and is doing good work. E. Canfield, engineer of the Ontario & Western at that time located at Middletown, N. Y., authorized the purchase.

Old Transit in Use Since 1873.

WESTERN CORRESPONDENCE SCHOOL.

The Western Correspondence School of Omaha, Neb., has prepared and has ready for issue a number of courses of instruction that are particularly of value to railroad men.

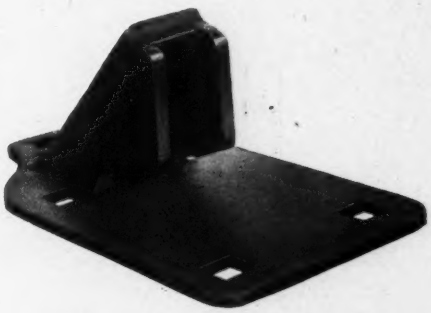
It is understood that the endeavor of the school will be to conduct its correspondence instruction by giving, as far as possible, a personal attention to the students. No effort is to be made to commercialize the proposition by swelling the enrollment so that the possibilities for personal attention will be remote. Another departure from the methods of other schools is that although courses of instruction are available, instructional matter need not be purchased as courses, but can be obtained on the lesson plan. Prospective students will not have to sign a contract and subscribe for a complete course unless they so desire.

The minimum charge for any service will be $2.00, upon receipt of which two lessons bearing on the subjects in which the subscriber is interested will be mailed him, and subsequent lessons furnished at the rate of $1.00 per lesson upon request. It is believed that this distinct departure from usual methods will appeal to many men, since they will not have to purchase a lot of instructional matter that may be a part of one of the courses, and in which they have no special interest.

The texts have all been specially prepared by writers who are railroad men, some of whom have been associated with railway educational work. As a result of this experience it has been learned what is of most value to railroad men, and in what they are most interested; so the method of preparing text matter is one that results in giving railroad men what they really want.

COMBINATION RAIL BRACE AND TIE PLATE.

The illustrations herewith are of a new device, a combination tie plate and rail brace. The design was made after a study of the conditions to be met, one of the primary objects being to produce a device of the utmost simplicity, so that unskilled labor could have no possible chance of losing or wrongly applying the device. The liability of loss of parts was one of the considerations which led to the adoption of a one-piece appliance. Strength was also required and it was quite a problem to work this out without sacrificing simplicity.



Combination Rail Brace and Tie Plate.

The device requires no fastenings except ordinary drive spikes. Five of these are used, and due to the one-piece construction, the entire number of spikes resists the tendency of the rail to spread.

The combination brace and plate for ordinary track develops great resistance to the canting tendency of the rail, this being increased by the gripping of the shoulder of the brace portion on the rail base.

With the guard rail brace it would be almost impossible for the track rail to cant without breaking the plate, which is constructed of sufficiently heavy material so that there is little liability that this would happen. It is an especially rigid device for resisting

Combination Rail Brace and Tie Plate for Guard Rails.

the destructive wheel forces which tend to force the guard rail out of position.

The device is especially adapted to severe conditions of curvature and to use on soft ties where the holding power of a single spike is insufficient to prevent spreading.

The combination rail brace and tie plate described herein is being marketed by the Millies Railway Construction Appliance Co., Hammond, Ind.

SIDE CLEARANCE TELL TALE.

A "Safety First" aid recently developed and put on the market by Selbert M. Connor, 12 South Jefferson street, Chicago, is shown in the accompanying illustration as it would appear installed. The device has been named a "Tell Tale" or "Warning for Building or Side Clearances," and its application is much the same as that for bridges, except that the position is vertical and at the side of the track, instead of horizontal and overhead. The distance from center of track to center of pole is in most cases about nine feet.

Side Clearance Tell-Tale

The aim is to prevent injury to persons aboard moving trains, who for any reason are not in the clear, and are liable to injury from too close side clearance. The pole is about thirteen feet six inches in height above foundation, and is made of steel pipe two inches and three inches in diameter respectively, with standard cast iron base as used for three-inch relay or cable posts.

The flexible fingers are two feet six inches from center of pole to tip, and though very flexible, resume original position when released, and the outer ends being especially so, are tipped with cork balls one and one-half inches in diameter. Fingers are fully protected from the weather by being rubber covered.

TIE TONGS.

For many years it has been the custom to handle ties with picks or shovels, thereby causing considerable injury to the ties through holes made in them previous to spiking in the track.

While the effects of this injury are self evident, it is not generally realized what an inefficient method either of the above is, as respects the actual placing of the ties in track. It is rarely, if ever, that the tie is placed by one hold on the tie, several attempts being necessary, each one of course adding to the mutilation. Then there is always the danger of the hold slipping and letting a man fall.

When treated ties are used, there is a great reluctance on the part of laborers to handling these directly with the hands. Creosoted ties are slippery and the oil is very disagreeable. In treating plants using creosote it has been found almost a necessity to install shower baths to give the laborers a chance to rid themselves of this oil before leaving the work. Zinc chloride is very disagreeable if it gets into a workman's eyes, which frequently happens by a man unwittingly rubbing his eyes after handling zinc treated ties.

The advantage of a tie tong is recognized at a glance. It grips the tie without making a deep hole in it, and if the teeth are sharp enough, one hold will suffice to drag a tie almost any distance. What small holes are made are really insignificant, and besides they are made in the sides of the tie, which is protected the best.

The C.-H. tie tong, illustrated on this page, is manufactured by the Cafferty-Hayden Co., Topeka, Kan.

C.-H. Tie Tongs.

THE JONES PURCHASING AGENCY at Minneapolis, Minn., deals in railroad and contractors' supplies. The head of the concern, Mr. P. W. Jones, is a graduate mechanical engineer who was a railroad contractor, superintendent and general contractor for twenty years. His wide experience in erecting and operating steam shovels has gained for him the name "Steam Shovel Jones." He took the first steam shovel, a No. 1 Osgood, to Minneapolis in 1879. His wide acquaintance was formed in his younger days among men who are now prominent railway officials and contractors, but at that time were holding inferior positions. This company specializes in the purchase of second-hand equipment, having frequently purchased the entire equipment of small railways.

A. E. SCHAFER, R. R. Sales Manager
Flint Varnish Works.

As announced in our February issue, A. E. Schafer has been appointed railroad sales manager of the FLINT VARNISH WORKS, office at Flint, Mich.

His life work has been devoted almost entirely to paint and varnish manufacture, in that he associated himself as a boy with the factory of the Sherwin-Williams Co. at Cleveland in 1881 and continued with them until January 1, 1909, during which period he occupied a large variety of positions, running very largely through the manufacturing, advertising and sales departments. Of the twenty-eight years of service with them, thirteen were spent as their sales representative in various territories and departments and the last six were spent in the capacity of general sales manager, with entire responsibility for marketing the product of the company outside of one of its specialty lines. From 1909 to January 1, 1913, he was engaged in the manufacture of automobiles.